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THE WATER POWER PLANT of the St. Lawrence Power Co. at Massena, N. Y., was visited on Oct. 27 and 28 by a party of engineers and others, including several representatives of technical journals, who were taken from New York on a special car through the courtesy of the company. The enterprise now under way at Massena involves the development of some 70,000-HP. from the waters of the St. Lawrence River. The canal from the St. Lawrence to the power house, about three miles in length, is about four-fifths completed. The power-house itself is nearly done and the turbines are now being set. We shall give a full account of the work in an early issue.

THE 39TH ST. INTERCEPTING SEWER TUNNEL in Chicago has now been relet to a new contractor and work is to be resumed. The contract has been awarded to John P. Agnew, of Chicago, at $637,200, or $118 per ft. The next bid was that of Gahan & Byrne, at $129.38 per ft. The work comprises the 5,400 ft. of the work which remained unfinished when the original contractors, the Chicago Star Dredging & Construction Co., failed and abandoned the work. It extends from Butler St. to Dearborn St., and Vincennes Ave. to Lake Ave. It is expected that it will be completed in about 18 months. The work was described in our issue of April 21, 1898, and the Hastings tunnel shield employed was illustrated in our issue of Aug. 3, 1899.

THE NEW HARBOR WORKS AT ROSARIO, Argentine Republic, will be let next spring. Tenders must be sent to the Argentine Legation, in London, not later than April 10, 1901, or to the Ministry of Public Works, Buenos Ayres, not later than May 10, 1901. Plans of the work may be examined at the Commercial Department of the Foreign Office in London, says the London "Board of Trade Journal," and possibly at our own State Department in Washington.

BIDS FOR A 30-IN. STEEL, CAST IRON AND WOOD WATER MAIN across the meadows at Atlantic City, N. J., will be invited as a result of the recent discussion (Eng. News, Oct. 4, 1900) there as to which material is preferable, in view of the local conditions. Mr. W. C. Hawley, Assoc. Am. Soc. C. E., is engineer of the water department.

THE STATEN ISLAND-LONG ISLAND TUNNEL is again under discussion. The New Jersey & Staten Island Junction Ry., first organized by Mr. Erastus Wyman, has passed into other hands, and Mr. Stephen M. Hoye, of Brooklyn, was elected President of the new company on Oct. 27. The capital is $10,000,000 and a tunnel is proposed across the Narrows, from Stapleton to Bay Ridge, with a connecting road leading from New Jersey across the Arthur Kill bridge to Staten Island. The tunnel would strike the Brooklyn shore near Owl's Head and turning north the tracks would strike the Long Island R. R. at 65th St., where they are depressed. After crossing these tracks the line would continue to 39th St. and the Bay. Charles F. Wood, of Philadelphia, is said to be the engineer of the proposed tunnel line.

THE RIVER AND HARBOR IMPROVEMENT ESTIMates, for the fiscal year ending in 1902, as submitted by Gen. J. M. Wilson, Chief of Engineers, aggregate $20,000,000. To this must be added $200,000 for surveys and contingencies, $3,890,000 for the Mississippi River Commission, $1,040,000 for the Missouri River Commission, $15,000 for the California Debris Commission, and $72,800 to prevent deposits in New York harbor. The expenditures for the year ending in 1900 were $18,485,396, exclusive of $125,000 paid the Eads estate for maintaining the jetties at the mouth of the Mississippi and $61,000 for surveys and examinations for a canal from the Great Lakes to the Atlantic.

OUR COAST DEFENCES, says the report of Gen. J. M. Wilson, Chief of Engineers, are in a state of gratifying progress. To the present time (June 30, 1900), thirty localities have been selected for defense on the coast. Attention has been given to defending the entrance to Chesapeake Bay and to the coast defenses of Porto Rico and the Hawaiian Islands. The defense of the harbor of San Juan, in Porto Rico, is estimated to cost $1,800,000, and plans are ready for the projects at Pearl Harbor and Honolulu. The estimates for the next fiscal year amount to $5,715,000, including $4,710,000 for constructing gun and mortar batteries and position finders. Twenty-five of the principal harbors of the United States have now enough of modern guns in place to offer effective defense against naval attack, and 50% of the work contemplated by the Endicott board is completed; or, 309 heavy guns mounted out of 480 contemplated, 368 rapid-fire guns out of 850, and 372 mortars out of 900.

A CHICAGO INLAND HARBOR is proposed by the Trustees of the Sanitary District; provided the Trustees can maintain their repudiation of a contract with the State Canal Commission requiring them to maintain navigation in the old Illinois and Michigan channels. The Engineering Committee has recommended that notice be served upon the Canal Commissioners that the Bridgeport Pumping Works will be abandoned on Nov. 15, and this recommendation is formally approved by the Trustees, under advice from their counsel that the contract referred to is illegal. If the Trustees win the Chicago and Calumet Rivers will be connected by a navigable channel not having an independent entrance to the lake. The canal will lock into the drainage canal at Romeoville, but the expense of the lock will have to be met by the state.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the line of the Northern Pacific R. R. at Dehart, Mont., on Oct. 28. A passenger train was derailed by the breaking of a switch-rod. Six passengers were killed and several injured.——On Oct. 22 a freight train was derailed and wrecked by a cow on the track of the Bald Eagle Valley branch of the Pennsylvania R. R., resulting in the deaths of four men.

A DISASTROUS EXPLOSION wrecked the building of Tarrant & Co., wholesale druggists, at the corner of Greenwich and Warren Sts., in New York city, on Oct. 29. The building was set on fire by some cause at present unknown, and after the fire had been in progress ten or fifteen minutes a violent explosion occurred. This was followed three or four minutes later by a series of half a dozen explosions at intervals of a half second or less, and so severe that the shock was plainly felt in the framework of tall office buildings nearly half a mile away. The cause of the explosion has not yet been determined. The fire was spread by the explosion and buildings were destroyed covering an acre or more, while some 30 or more persons are believed to have lost their lives.

THE ANNUAL FIRE WASTE is discussed by Mr. F. O. Affeld, of New York, who says that he finds by the fire records for 1890 of six principal European cities—Paris, Berlin, St. Petersburg, Hamburg, Constantinople and Dublin, the average loss per capita is 46 cts. Taking New York as a typical American city, he finds the average loss is $2.80 per capita; and in a term of eight years the average loss ratio was $2.49, and in 1899 it was $3.36. He believes that the bulk of this loss is due to the carelessness of property-owners, and he thinks that the ease and promptness with which fire losses are settled by the insurance companies encourages this carelessnes in the way of over-insurance. Mr. Affeld says that the laws of twenty states compel the companies to pay the full amount insured, in case of total destruction, without reference to actual value. The laws as they exist encourage dishonest practices on the part of those insuring, and run up the apparent losses, as shown above.

THE CAUSE AND PREVENTION OF FIRES IN WAREhouses has been reported upon by Dr. A. M. Read as chairman of a committee of the American Warehousemen's Association. Eliminating the causes that could not possibly operate in a well-regulated warehouse, Dr. Read confines himself to fires arising from electric fittings, steam pipes and spontaneous combustion. The greatest danger from electricity lies in bad workmanship and bad material. The faults of manufacture are being rapidly eliminated by the action of the National Fire Underwriters' Association; and the faults of construction are much lessened by the inspections made under the authority of this association. There is still danger from systems of electric wiring put in from two to fifteen years ago and some danger from that now being put in, from short circuits breaking lamps, from defective transformers, overloading of wires, grounding of the current, falling of wires across gas-pipes, the contact of wires of different potentials, abrasion of flexible cords, etc. Dr. Read recommends that all electric light and power wires be laid in rubber-lined iron tubes, and that all material used be of a kind tested and recommended by the National Association of Fire Underwriters, whose lists can be obtained from insurance agents. Inspection of all electrical fittings by a competent expert at least once in six months is also recommended. Private fire service, fireproof warehouse construction and constant vigilance in the storing of materials liable to spontaneous combustion will largely eliminate danger from fire.

THE RUSSIAN BATTLESHIP "RETVIZAN" was launched at Cramp's shipyard, in Philadelphia, on Oct. 23. This battleship is the largest built in this country. This ship is 376 ft. long between perpendiculars, 72 ft. 2⅛ ins. beam, and displaces 12,700 tons on 26 ft. draft. The contract speed is 18 knots for 12 continuous hours at full displacement. The main battery will include four 12-in. and twelve 6-in. guns, with 20 3-in. guns and six torpedo-tubes. The main armor-belt is 9 ins. thick and the gun-casements are 5 ins. thick, with a protective deck from 4 to 2 ins. thick. All armor is made by the Krupp process. The total cost will be $3,000,000.

THE WHITE STAR STEAMSHIP "RUNIC" was launched at Belfast on Oct. 25. This vessel is 565 ft. long, 64 ft. beam and 12,400 tons gross tonnage. She has twin screws and is generally similar to the "Afric," "Medic" and "Persic," of the same line. In this ship the dining room, seating 400 passengers, and the writing and reading rooms are all on the upper deck. The "Runic" can carry 100,000 carcases of mutton in refrigerated compartments, and 20,000 bales of wool. She is intended for the South African and Australian service.

THE STEAMSHIP "WACCAMAW," of the Atlantic Coast Steamship Co., has arrived in New York. This is the first of a fleet of six vessels being built for this company. It was launched from the Craig shipyard, at Toledo, O., and came here through the Canadian canals. The "Waccamaw" is 258 ft. long, 40 ft. beam, and 18 ft. 3 ins. draft. The hull is built of open-hearth mild steel and is fitted fore and aft with a double bottom, for water ballast, with solid plate bulkheads and a single deck, the interior being especially arranged for carrying lumber. The engines are triple expansion, direct-acting vertical, with 20, 33 and 54-in. cylinders and 40-in. stroke. The two "Scotch" boilers are each 12 ft. 4 ins. diameter and 11 ft. 6 ins. long, built for a working pressure of 170 lbs. per sq. in. This steamer and its consorts are to be principally employed in the lumber trade on the Atlantic coast and the company now has docks at Georgetown, S. C., with a storage capacity under cover of 15,000 tons. The company has a capital of $1,000,000 and has lately purchased and is re-equipping and extending the Georgetown & Western Railway reaching the lumber regions of South Carolina. The "Georgetown," the second vessel of the fleet, is being built at the Union Dry Dock Co.'s yard, at Buffalo, N. Y., and will be completed in June next.

THE TURRET-STEAMER "NORANMORE" arrived at Baltimore on Oct. 26, from Liverpool. This is the largest turret steamship afloat and belongs to the Johnston Line. The "Noranmore" is built of steel and is 420 ft. long, 50 ft. beam and carries a cargo of 9,000 tons. She has triple expansion engines of 27½, 45½ and 75 ins. diameter. When loaded she has a free board of only 16½ ins., with a bridge 35 ft. above the water surface. She is a modification of the American whale back built by W. Doxford & Son, of Sunderland, and possesses the merit of carrying a cargo of 9,000 tons on a registered tonnage of 3,650 tons, and 5,600 tons gross. She is said to be a good sea boat and dry.

A EUROPEAN COAL FLEET is reported as in contemplation by the Chesapeake & Ohio R. R. Co. and certain eastern capitalists. The rumor says that $2,000,000 may be expended in building twenty 5-masted schooners to sail from Norfolk and Newport News with coal for foreign ports.

A MARKED FALL IN THE PRICE of manufactured goods is reported by the Treasury Bureau of Statistics for October, as compared with prices at the beginning of this year. Tin-plate shows a reduction of 24%; refined petroleum, 21%; common window glass, 12%; wire nails, 30%; barbed wire, 26%; Bessemer pig-iron, 46%; steel rails, 26%; yellow pine lumber, 14%; sisal rope, 38%; manila rope, 32%. A reduction of from 5 to 12% also holds good in dress goods, shoes, etc. On the other hand, the prices of farm products for October, show an advance as compared with January, 1900. Corn has advanced from 39½ to 48½ cts., per bushel; wheat, from 73.8 to 79.7 cts.; barley, 45 to 59 cts.; cotton, from 7 11-16 to 10.8 cts., etc.

STRENGTHENING THE MICHIGAN CENTRAL R. R. CANTILEVER BRIDGE, NIAGARA FALLS, N. Y.

(With two-page plate.)

The Niagara cantilever bridge, built in 1883 to carry the double tracks of the Michigan Central R. R. over the gorge of the Niagara River about two miles below the Falls, was the first bridge of its type to be erected in the United States. A very complete description of this notable structure was published in the issues of Engineering News for March 12, 1881; Oct. 6 and Dec. 29, 1883, and May 17, 1884. Summarizing briefly the general information given in these articles: The bridge spans a chasm about 850 ft. in width between the bluffs and 210 ft. in depth to the surface of the water. The sides of this chasm or gorge beginning at the water's edge have a slope inshore and upward of about 45° to a point about 50 ft. below the top of the cliff, above which they are vertical. The river is about 425 ft. wide at the bridge site. The bridge itself is a double track deck structure consisting of two cantilevers which rest on iron towers and whose shore ends are anchored to masonry piers, the river ends being connected by a suspended span. The principal dimensions are as follows: Distance c. to c. of anchorage piers, 910 ft. 2½ ins.; length of each cantilever, 395 ft. 2 5-16 ins., c. to c. of end pins; length of suspended span, 119 ft. 9⅞ ins., c. to c. of end pins. The cantilevers and suspended span are made up of two parallel trusses spread 28 ft. apart c. to c. The top chords of the cantilever trusses were made of iron eye-bars and the bottom chords of high carbon steel. The towers were of iron carried on masonry pedestals and the anchorages were of masonry.

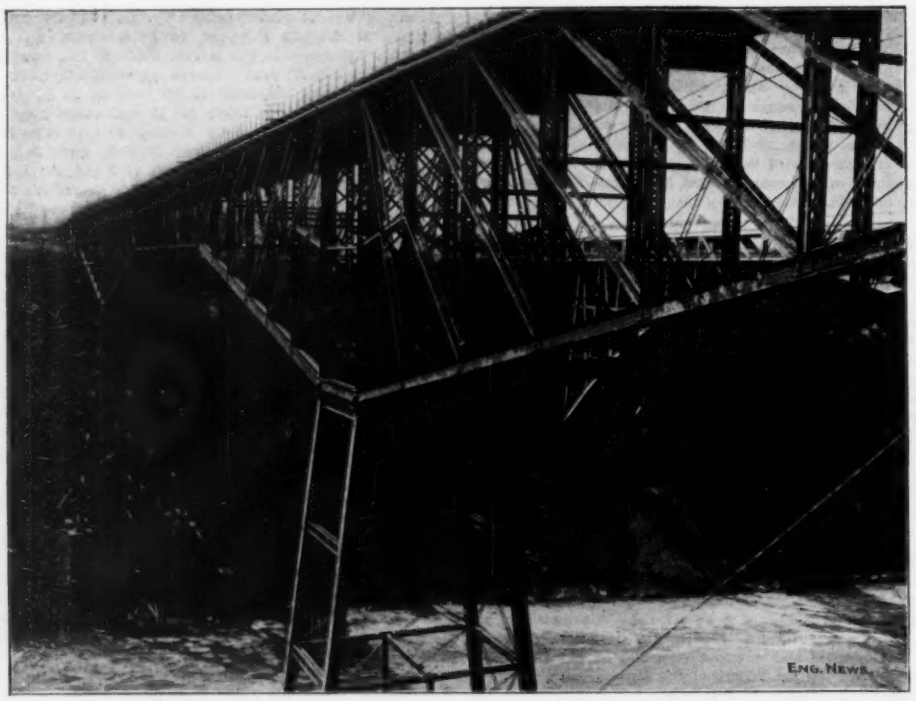


FIG. 2.—GENERAL VIEW OF BRIDGE AT BEGINNING OF WORK.

For some years the Michigan Central R. R. Co., which owns the bridge, has had in mind its strengthening not so much because it is unsafe under present loads as because the near future will evidently see trains and locomotives much heavier than are now being run across the bridge and heavier than are thought entirely safe for the original structure. In 1899 it was decided to undertake the work, and plans were prepared and the contract for carrying them out was let to the Detroit Bridge & Iron Works of Detroit, Mich. Briefly described the plan of strengthening adopted was to construct a third truss midway between the two original trusses and 50% stronger than either of the old trusses and to build new tower legs and anchorages to support this new truss. New sway and bottom lateral bracing was also planned for. The accompanying drawings show the details of the new work.

The first task of course was to reconstruct the anchorages and shore piers to accommodate the new center truss. To construct the anchorage a set of 6 × 1¾-in. anchor rods were carried down through the center of the old anchorage pier and attached to an I-beam grillage placed in an anchor pit excavated in the solid rock beneath the pier. The drawings, Fig. 1, show the construction quite clearly. As will be seen, the rods obtained their pull against the grillage by means of heavy steel washer plates and nuts on the threaded ends of the rods. At their tops the anchor rods had eyes through which a 7-in. steel pin was passed. Four short eye-bar links connected this pin with the 10-in. end pin of the new truss. The minor details and the dimensions of the remodelled anchorage are shown clearly by Fig. 1.

Turning now to the shore piers it will be seen from Fig. 2 that they consisted in each case of four steel tower legs resting on masonry pedestals and connected by horizontal and diagonal bracing to form a steel tower. To strengthen the tower to carry the new truss a pair of legs was inserted midway between the old tower legs and directly under the line of the new center truss. The view, Fig. 3, shows the location of the new tower legs and of the new masonry pedestals designed to support them. Fig. 4 is a close view of the foot of one of the new tower legs, showing the pedestal casting which supports it on the masonry. In erecting the new tower legs it was desirable to avoid cutting the transverse bracing of the old tower, as this came into action whenever a train crossed the bridge. The new posts were, therefor, erected piecemeal in the field. Each post consisted of two built-up channels connected by diagonal lacing and tie plate. The channels were erected first, which could be done without cutting the transverse bracing, and when in place the lacing and tie plates were riveted to the channels to complete the post. It may be noted here also that the vertical posts in the new truss which came directly over the tower legs were erected in a similar manner. Fig. 5 shows the steel castings for the tops of the new tower legs, which, it will be seen, are bored to engage the 8-in. steel pins which connect the posts and lower chord members of the truss at these points. The pedestals at the bottoms of the tower legs are of cast iron.

The new truss is described in a letter to us from Mr. Benjamin Douglas, M. Am. Soc. C. E., Bridge Engineer, Michigan Central R. R., as follows:

> The new truss is intended to be 50% stronger than either of the old trusses. Its form and the sections of its various members are carefully designed so as to give the same deflection at each point as there will be in the old trusses, assuming that three-sevenths of the load on each track is carried by the new trusses, and four-sevenths by the two old trusses. The bottom chords of the old cantilever trusses are made of high carbon steel and the top chords of iron eye-bars. At the time the strengthening was decided on, it was difficult to get any special steel within a reasonable time and it was therefore decided not to use high carbon steel in the new trusses, but to use a softer steel, with larger cross sections, and to reduce the sections of the top chord so as to leave the deflections at all points the same as in the old trusses. It was not found practicable to compensate for the increased stiffness due to the enlargement of the two panels of the bottom chord each side of the tower by making any changes in the sections of other members. It was therefore decided to reinforce the corresponding panels of the old trusses and thereby increase their stiffness to correspond with that of the center truss.

Briefly described, the new truss consists of a bottom chord of stiff built-up members, stiff built-up vertical posts and eye-bar diagonals, with a top chord of stiff built-up members for the first five panels at each end and of steel eye-bars for the remainder of its length. All connections are made with steel pins. This is exactly the same style of construction as was used in the old trusses shown by Fig. 2. Only the principal members of the third and fourth panels from the tower of the river arm of the new truss will be illustrated here, since the corresponding members of the other panels differ from these only in dimensions and minor details. Fig. 6 shows the construction of the lower chord for these two panels and Fig. 7 shows the construction of the vertical post between them. It will be observed that the post has the regular pin connection at the bottom and also a pin connection for the eye-bar diagonals about midway of its height.

At the top of the post the construction varies from the normal pin connection detail on account of the fact that it was deemed inadvisable to cut the old floor beams. The top of the post is designed to straddle these floor beams and to support them in the manner clearly indicated by the top end details. To form the necessary pin connection for the top chord eye-bars, a steel casting of the form shown by Fig. 8 is bolted to the top of the post just above the top chord of the floor beam. The location of this casting is somewhat more clearly explained by the view, Fig. 9. The eye-bars forming the top chords and the diagonals require no particular description.

Besides the main truss members, the new work included the complete reconstruction of the bottom lateral bracing and new sway bracing throughout. This new bracing is of the same general character as the old bracing which it replaces. The top lateral bracing was not changed. By referring to Fig. 2 and remembering that the new truss resembles the old trusses in all its general features, the preceding description will be ample to explain the structural details of the new work. As previously stated, the new steel work was manufactured by the Detroit Bridge and Iron Works of Detroit, Mich.

Except the rivets, all the material in the trusses is either high steel or what is known in the Michigan Central R. R. Co.'s specification as Class A steel. Generally speaking, the bottom chords of the cantilever portions of the new truss and the tower legs and vertical posts over the towers are high steel and all other members are Class A steel. The specifications for these two classes of material are as follows:

> HIGH STEEL.—Material marked high steel is to be open-hearth steel with an ultimate strength of 66,000 to 74,000 lbs., an elastic limit of 55% of the ultimate strength, and an elongation of 22% for steel of 66,000 lbs. strength. The reduction of area is to be 45% with a fracture silky throughout. Test specimen is to bend 180° about a pin, with diameter equal to one-half the thickness of the specimen, without sign of fracture. Sulphur is not to exceed 4-100%, and phosphorous not to exceed 4-100% for basic or 75-1,000% for acid steel.
>
> CLASS A STEEL.—Class A steel shall be made by the open-hearth process, and contain not more than 8-100% of phosphorous if made by the acid, or 5-100% if made by the basic process. It shall have an ultimate strength not less than 57,000 or more than 66,000 lbs. per sq. in., and an elastic limit not less than 55% of its ultimate strength. Its elongation in 8 ins. shall be not less than 26% for steel of 57,000 lbs. ultimate strength, with a reduction of ⅜% for each additional 1,000 lbs. of ultimate strength, down to a minimum of 23%. The reduction of area at point of fracture shall be not less than 46%. It shall stand bending cold, under a hammer, until the sides of the test piece are in contact throughout their entire length without sign of fracture on the convex side of the curve.

ERECTION.

The erection of the new tower legs, truss and anchorages is being done by the Bridge Department of the Michigan Central R. R., Mr. G. C. Tuthill, Assistant Bridge Engineer, being in direct charge of the work. The tower legs and the new anchorages were the first to be built, and beyond

what has already been said the work calls for no especial mention. The erection of the new truss had to be so planned that traffic over the bridge should be interefered with as little as possible. The north, or downstream, track was closed to traffic and arranged to be used as a material track, and the flooring at the center of the bridge was opened up, as is shown clearly by Fig. 9. The next step was to construct a traveler to lower the material into place. This traveler is shown by Fig. 10. It is mounted on car wheels, which run on lines of rails laid on timbers close to the side railings of the bridge, and the cabins for the hoisting engines overhang on each side. The view, Fig. 10, shows the method of lowering the members. The traveler has a capacity of 28 tons, and the heaviest member handled by it weighed 14 tons.

The method of operation is very simple. The posts and bottom chord members are lowered into place and temporarily fastened. and then the upper chord

Fig. 3.—View of Canadian Tower, Showing New Tower Legs in Place.

eye-bars are placed as shown by Fig. 9. The diagonal web members and the new lateral and sway bracing are erected last. To accommodate the workmen, a staging is hung from the bottom chords of the old trusses and smaller stagings are erected as they are needed. The field riveting is all done by pneumatic riveters supplied with air by two Fairbanks-Morse gasoline engine compressors. The compressors are located on the American shore and the air is conveyed to the riveters through iron pipes and hose. The steel work is stored in the company's yard on the Canadian shore and is conveyed to the traveler on push cars. The erection gang averages about 50 men. Work erecting the iron work was begun in April, 1900, and it is expected that it will be completed by the end of this year.

This brief description in connection with the drawings and views given on our two-page plate will give a fairly clear idea of the work which is being done. As already stated, the steel work is being manufactured by the Detroit Bridge & Iron Co., of Detroit, Mich., and the erection is being done by the Bridge Department of the Michigan Central R. R., of which Mr. A. Torrey is Chief Engineer and Mr. Benjamin Douglas, M. Am. Soc. C. E., is Bridge Engineer. Mr. Alfred Noble, M. Am. Soc. C. E., is Consulting Engineer of the work. The construction of the masonry was in charge of Mr. W. J. Duncan, Assistant Engineer, and the erection of the steel work is being directed by Mr. G. C. Tuthill, Assistant Engineer. We are indebted to Mr. Douglas and to Mr. Tuthill for the information from which this description has been prepared.

A NEW LIFE-SAVING NET has been successfully tested by the New York Fire Department. There is a circular ring of iron pipe to which a padded canvas net is secured by springs, 15 ins. long and about 12 ins. apart. The springs seem to do away with much of the jar and shock produced by a falling body, and to test it a fireman jumped into the net from the fourth story of a building.

A NEW METHOD OF PRODUCING HIGH TEMPERATURES.*

By Ernest F. Lange, F. C. S.†

In the month of June last I was invited to Essen, in company with Mr. Henry Cooper, Engineer to Messrs. Vickers, Sons & Maxim, to witness some experiments introducing a new method for the production of high temperatures for certain metallurgical purposes, hitherto unobtainable except by means of the electric arc, this new method being the outcome of researches made by Dr. Hans Goldschmidt of that town.

The experiments, which were held at the works of the Chemische Thermo-Industrie Company, clearly showed to Mr. Cooper and myself that for various metallurgical purposes the engineer and chemist had now at their disposal a new and powerful agent sufficiently cheap and effective and sufficiently under control to justify its existence both from a practical and commercial point of view. The principle underlying the process is not new, as the same is based upon the heat energy developed by the chemical action of aluminium upon oxygen, or rather that between aluminium and certain metallic oxides: it is rather the manner in which this action is developed and its product applied which constitutes the novelty of the process.

EARLY RESEARCHES.

The use of aluminium as a reducing agent has been known for many years. Shortly after its discovery by Woehler, of Goettingen, and its first production on a commercial scale by Henri Sainte-Claire Deville, who may justly be regarded as the founder of the aluminium industry, various experimenters showed that metals could be separated from their combinations by combustion with aluminium. Bunsen, Tissier, Michel, Beketoff, Rose, and others, not forgetting our own Dr. Percy, made experiments which in the aggregate demonstrated the reducibility of metals from their chlorides, fluorides, sulphides, oxides, and other compounds by means of aluminium. These observations were only carried out on a small scale, and were effected by crucibles placed in a small furnace, the reactions being often violent enough to scatter the contents of the same. In recent times other investigators carried out a series of experiments sufficiently complete to show that a long series of metallic oxides were reducible by aluminium. In these cases, also, the reagents were heated by means of a crucible placed in a coke furnace. Again, Messrs. Greene and Wahl, of Philadelphia, have for some years been producing pure manganese on a commercial scale by dissolving manganese oxide in molten cryolite and adding metallic aluminium thereto. Some very interesting laboratory experiments, showing the possibility of producing pure iron by reducing ferrous oxide with aluminium, were brought before this Institute at its Birmingham meeting on Aug. 21, 1895, by one of our Members of Council, whose services to the metallurgy of iron and steel have been of the most valuable kind—I allude to Robert Abbott Hadfield; and on March 15 in the same year our President, Sir William Roberts-Austen, gave a brilliant demonstration before the Royal Institution upon the "Reduction of the Rarer Metals from their Oxides," on which occasion several of the rarer metals were produced in some quantity by reduction with aluminium in a manner which appeared almost magical. Among other valuable investigations since then have been those of Moissan in producing aluminium alloys by the addition of metallic oxides to a bath of molten aluminium; and those of Kupelwieser and Matignon in determining the calorific effect of certain reductions with aluminium; and also the researches of Helouis in reducing vanadium, Dubois and Gauthier in reducing boron and silicon; and the interesting experiments of Francke, wherein he showed the reductibility of phosphorus from sodium phosphate by treatment with aluminium.

GOLDSCHMIDT'S EXPERIMENTS.

Early researches with the oxides led Dr. Goldschmidt to make further experiments, with the object of discovering a mode of controlling the violent reaction obtained by the heating of aluminium in contact with metallic oxides, and these brought to light the important fact that it was not necessary to heat the whole mass up to the requisite temperature for ignition, but that it sufficed to start ignition at any one point when, combustion once started, the reaction proceeded steadily with more or less speed throughout the whole mass, thus generating within itself the whole of the heat required for the action. In the case of the refractory oxides it would have been a difficult matter to apply the requisite heat for ignition at any point had not Dr. Goldschmidt made the still more important discovery that, although certain oxides combined with aluminium at so low a temperature that they could be ignited with an ordinary match, yet they nevertheless in their combustion developed so much heat that if a small quantity thereof was placed upon a mixture of refractory oxide and aluminium and ignited, a reaction was started in the same which, thus originated, then proceeded automatically as before.

NATURE OF CHEMICAL REACTIONS.

We will take, as example, the action of aluminium on iron oxide. If we mix together finely divided aluminium and oxide of iron in the proportion of their chemical equivalents, and start ignition at any point, we get a reaction which may be simply expressed as follows:

$$Fe_2O_3 + Al_2 = Al_2O_3 + Fe_2,$$

the products being alumina and iron. As no silicious material can withstand the action of the hot alumina, a crucible lined with magnesite is preferably used. Into this crucible is first brought a little of the mixture for the reaction, and upon this is placed a good pinch of the igniting powder. This powder, as before said, consists of a mixture of aluminium and oxides with which it combines at a low temperature. For example, we may use barium peroxide mixed with a little magnesium or calcium carbide to make ignition more certain, or some of the nitrates or chlorates would do as well. The heat developed by the combustion of this mixture is sufficient to start the reaction between the aluminium and iron oxide mixture and as this proceeds we keep adding more and more of the same, until within a minute or two of time we have a crucible containing reduced iron covered by a thick coating of alumina slag. The light emitted by the reaction is so intense that the eyes require the protection of dark glasses. On pouring off the slag, the temperature of the underlying liquid iron can be tried by pouring the same on to a mild steel plate, or along the side of a mild steel bar, when it will be seen that the hot iron cuts its way through with ease. Pyrometer experiments with the Wiborgh thermophone have established the temperature reached in the operation at about 2900° C. to 3000° C., that is to say, 1000° C. more than that reached during the hottest period of the Bessemer blow. In the case of the reduction of chrome from its oxide by this method, the temperature of 3,000° C. is certainly reached, a temperature hitherto obtainable by the electric arc alone.

The work represented by the heat energy of these operations is also very high, as we may assume that the energy set free by the combustion of the aluminium is about equal to that originally used for the reduction of the aluminium in the electric furnace, so that in a reaction as above described, but requiring a crucible of 10 litres (610 cu. ins.) capacity, thousands of horse-power are set free. Of course it will be understood that for many reasons more power must be used in the production of aluminium than is represented by the equation of the reaction.

It will doubtless occur to you that the crucible containing the reaction in progress may be likened to a poleless or secondary electric furnace, but having a much more speedy action. We must recognize the fact that in aluminium we have a very powerful source of heat, wonderfully condensed, and portable and adaptable to many industrial operations. Aluminium and oxygen are two of the most common elements of which the earth's crust is composed, and it can hardly be questioned that the price of aluminium, already low, will be still further reduced as the years roll on.

APPLICATION OF THE PROCESS TO THE PRODUCTION OF ALLOYS.

Before passing on to speak of some industrial applications of the aluminium and iron oxide reaction, I must consider the use of the Goldschmidt process as applied to the production of certain metals and alloys of interest to the makers of steel and other material. In the first place, I will take the production of pure carbonless chrome and manganese.

The oxides of chrome and manganese are reduced to the pure carbonless metals in the following manner: The oxide of the metal to be reduced is well mixed with aluminium. Some of the mixture is placed in a suitably lined crucible or tank, and combustion started in the manner already described. In the same degree as the reaction proceeds, further additions of the mixture are made. In consequence of the intense heat of the reaction, there is a separation out of the pure metal in the liquid state, a result hitherto obtainable in the case of chrome by the electric arc alone, the liquid metal being covered by a slag of alumina. The reaction can be made a continuous one by providing two tap-holes, one for the metal and one for the slag. As the reaction is a very quick one, it is possible with only a moderately sized crucible to oxidize 1 to 2 kilos. of aluminium per minute, and as the products of combustion are almost non-gaseous, the reaction continues with wonderful smoothness. It is in this way possible, with quite a small floor-space and in a very short time, to produce a large quantity of metal. It is important to observe that the metal can be produced free from aluminium by providing that a small excess of oxygen is present, and also, that as aluminium is free from carbon, the metals thus produced also contain no carbon. This pure chrome is almost incorrodible, and possesses also very valuable electrical properties, but I shall only more nearly explain its value for the steel-melter.

As is well known, chrome is used for alloying with steel in the form of a high per cent. ferrochrome. These ferrochromes are distinguished by a high carbon content. This very fact limits, in cases, the amount of chrome that can be added, but by using a carbonless chrome the limits are accordingly increased. For some months at Essen and at the St. Michel de Maurienne Works, Savoy, such carbonless chrome has been made and sold for the production

*Abstract of a paper read before the Iron and Steel Institute of Great Britain at its Paris Meeting.

†Manchester, England.

of chrome steel for armor plates and armor-piercing projectiles.

The manufacture of carbonless manganese is accomplished in the same manner as I have described in the case of the chrome. This manganese has certain advantages over the high per cent. ferromanganese; it does not disintegrate when exposed to the air, and it is particularly suitable for the manufacture of alloys of manganese with copper, tin, zinc, etc.; and it can also be used as a deoxidizing medium instead of magnesium in the manufacture of nickel castings.

I might mention two other alloys of interest to steelmakers made by this method, namely, carbonless ferrotitanium with 10% and 20% to 25% of titanium, and also a carbonless ferroboron with 20% to 25% of boron. I may also remark that almost all the other metals can be similarly produced by reduction through aluminium; for example, tungsten, nickel, cobalt, molybdenum, titanium, boron, vanadium, uranium, and the more easily fusible tin and lead, also the metals of the alkaline earths barium, strontium, and calcium. We can also produce a compound of lead and barium, which resolves water, and a chrome manganese and a chrome copper, both of which can be made the basis of useful alloys. The most important exception among the metals irreducible by aluminium is magnesium, which, as Clemens Winkler demonstrated in the year 1890, is itself able to reduce alumina. Samples of the pure chrome, manganese, other metals, and alloys produced by this process are exhibited before you on the table. I may here mention that the molten oxide of aluminium, of which the slags produced in these reducing actions consist, is in itself a valuable substance, as it constitutes what is practically artificial corundum or emery, with the advantage over the latter that it contains no combined water, and thus makes a very hard grinding material. It also forms one of the few possible materials out of which crucibles for the reaction can be made. It is also valuable as a source of new aluminium for the smelters of that metal.

INDUSTRIAL APPLICATIONS.

For all industrial purposes, where it is merely desired to make use of the heating effects produced by the oxidation of aluminium, the most effective and economical source of oxygen is that contained in the oxides of iron; and I must now draw attention once more to this reaction. It is above all suitable for producing heat for welding purposes. The operation is conducted by pressing together the two ends of the bars or pieces to be welded. There is then placed round the part to be welded, but separated from it by a fixed distance, a form made of thin iron sheeting, supported by being packed round with moulding sand. The aluminium-iron-oxide combustion is then effected in a crucible of fitting size, and the contents of the crucible poured into the form. As soon as the part to be welded has taken up sufficient heat, the weld is accomplished by pressing the two parts together by means of a suitable clamping arrangement.

It stands to reason that inasmuch as we require different degrees of heat for the various purposes to which the aluminium-iron-oxide reaction can be put, we can regulate the mixture in such a way as to obtain a greater or less heat from the oxidation of the aluminium. For example, we do not require the same temperature in heating or welding which we would for the reduction of the refractory metals. To this end we can dilute the iron oxide with sand, or magnesia, or lime. For the lower temperatures it is not even necessary to take pure aluminium, and a raw aluminium of 50% purity made from bauxite has a sufficient effect. Furthermore, when we require merely heat from reaction, it is a matter of indifference as to how far the reduced iron is pure or impure. On the other hand, if it is proposed to use the reduced iron to form part of an iron or steel structure, the purity or composition of the same might prove an important matter. In this way we can obtain by more or less dilution of the heat-giving agents by neutral substances a reaction which will produce any desired temperature up to that produced by the most effective conditions for combustions. At the lower temperatures we would obtain merely a sintering mass, whilst at the higher temperatures the slag is liquefied, and a regulus of metal formed beneath. In practice, however, it is better to use a high temperature reaction, taking for the lower temperature operations so much less of the reagents. Dr. Goldschmidt has found that two aluminium iron-oxide mixtures serve for most purposes, and at the works of the Chemische Thermo-Industrie in Essen the manufacture of these on a large scale has been for some time in progress. To these mixtures the name Thermit has been given; the one used for welding is called Thermit P, and that used for the production of a pure iron or steel at the highest temperatures is called Thermit R, and the composition of these mixtures has been patented.

Careful experiments have been made with a view to determine the amount of thermit necessary to heat up a given section of material to a welding heat, so that for a given piece of work the requisite size of crucible is known, and the welding calls for little skill or judgment on the part of the operator, and not more heat is produced than is necessary.

It might be thought that there was some danger of fusion of the material when the thermit is first poured on, but the peculiar characteristic of the slag, in respect of its fire-resisting properties, prevents this. At the end of the reaction in the crucible there are two fluid layers, below the fluid iron and above the light fluid alumina. On emptying the crucible, the slag pours off first, and congeals in a thin layer on the cold surfaces of the sheet-iron form and the material to be welded; the remainder of the slag and the whole of the iron poured out remain for some time fluid between the congealed linings of slag, which thus protect the form and weld from fusion. Two welding processes accomplished by this method I shall now proceed to describe more particularly. In the first place, I shall note the welding together of rails for electric, tram, and small railways.

The rails which Mr. Cooper and myself saw welded were 7-in. girder rails. A good joint having been made between the two ends, strong clamps were then secured to the rails, some 9 ins. or 10 ins. from the joint, and connected with each other by means of a strong bolt on each side of the rail. The sheet-iron form was then brought round the part to be welded, and backed round with fire clay. The reaction was then started in a crucible capable of taking 15 kilos. of the aluminium-iron-oxide mixture (thermit P), and at the end of the reaction, which lasted about a couple of minutes, the contents of the crucible were poured into the sheet-iron form surrounding the joint, care being taken that the slag made first contact with the cold surfaces. After waiting another couple of minutes, the rail ends were judged to be sufficiently heated, and a few turns of the nuts on the tension bolts were given equally and simultaneously, and the weld effected. An important feature about this welding process is that the layer of slag or corundum which first forms round the part to be welded also protects the joint from oxidation. After the welding, the solidified mass can be knocked away by a few light blows from a hammer; but, as a rule, it is better to allow it to remain on for some time, so as to allow of a more gradual cooling of the rail-joint. On knocking away the mass, it was seen that the sheet-iron form was so little damaged that it could be used over and over again.

With regard to the comparative cost of the joint as compared with a fishplate joint, Dr. Goldschmidt has got out some figures in which consideration is taken of the cost of maintenance of the fishplate joint, and makes out a favorable case for the welded joint. I do not feel justified in giving figures based upon the limited experience of the welds in practice, but considering that trial lengths of electrical tramway rails in Essen, Brunswick, Hamburg, Berlin, Dresden, Plauen, and other towns, have been welded by the process described, reliable data should shortly be available. The reports of the same are hitherto of a favorable kind. It appears more than likely that this process will be largely used in the future for securing continuity of conductivity for the return current in electric railways. It is of great importance in the working of such railways that there is perfect electrical contact between the rails. The copper connections hitherto used are not altogether reliable, being apt to work loose. When this occurs, wandering currents of electricity make their return by way of the underground gas and water pipes, setting up a destructive electrolysis which can in time do much damage. Very unfortunate experiences have already been made in some of the United States cities from this cause. Experience with welded girder rails has shown that there is no danger to be feared from the effect of expansion or contraction due to climatic changes, as the concrete or paving in which these are buried equalize the temperature.

With regard to the comparative cost of welding by thermit as against that of welding by electricity, it is hard to find common ground for a comparison, as the number of cases where electricity is sufficiently available and its use expedient is necessarily limited, and as far as I know, no comparison has been attempted. It is to be remarked that the fishplate joint and copper strip connection has hitherto formed the standard practice for electric railways in all countries.

As a second illustration of the utility of the new process for welding, I shall now mention the tube welding.

In the new works of the Chemische Thermo-Industrie in Essen, the steam service pipes are all welded together on this system, and we were informed that this had proved a considerably cheaper method of joining the pipes than the use of flanges and bolts.

Repairs were easily effected by cutting out the defective portion of the steel or iron tube, and welding a new piece in position. In the same way junction and expansion tubes could be introduced where necessary. It would thus seem that the process should prove of considerable utility in the construction of many kinds of tube installations where, from one reason or another, the flanged joint is not perfectly reliable or convenient.

As before explained, the weld is protected from any destructive action from the thermit by the fact of the thin protective layer of slag or corundum which spreads itself over the parts to be welded. This slag coating also insures freedom from oxidizing influences on the weld. This fact has been turned to account by using thermit for giving the heat for effecting hard soldering and also for the welding of copper. For example, iron and copper, bronze and brass, can be hard soldered by the heat of thermit suitably applied.

Another interesting application of the heat given off by thermit is that of the softening of armor-plates in places where it is desired to drill holes. This is effected in the simplest possible manner by pouring a small quantity of the hot fluid thermit into a form placed upon the part desired to be softened. The heat quickly penetrates into the body of the plate, softening the chilled carburized surface, which can, after a short interval of waiting, be drilled as required. This also was effectively demonstrated to Mr. Cooper and myself.

I have finally to mention the use of thermit for the production of small quantities of very hot metal for the purpose of repairing defective steel castings or for the thickening of any part of a steel piece where additional metal is found to be necessary. This is done by taking a suitable sized crucible, and starting the thermal reaction in the usual way. On the reaction being completed, the slag is very carefully poured off, and with the very hot and fluid metal that now remains, the blow-hole is filled up, or the defective part built up, as the case may be, the metal being guided by a small mould of ganister. A convenient feature of this process is the facility with which the reduced iron, or, to be more accurate, steel, can be made to resemble in composition the piece to which it is applied, for we can mix with the thremit beforehand silicon, manganese, or chrome to give to the steel a certain definite composition. It, however, seldom happens that the office to be performed by the small quantity of molten steel is such as to make this an important matter. The chief consideration is that it should set solidly. For most cases, therefore, Dr. Goldschmidt states that the standard mixture of thermit made at Essen for this purpose, and designated thermit R in contradistinction to the first-named thermit P, will be found efficient.

I regret that up to the time of writing this paper I have not yet been able to complete certain investigations I have entered upon to determine the mechanical and other properties of this alumino-genetic iron. Microstructure investigations would doubtless prove interesting as well, but I hope to be able to include some of them later on in the Proceedings of the Institute. I hope, however, that this account of the heat-producing properties of thermit, and the uses to which it can be put, will induce some of you to take up some of these interesting experiments for yourselves. I think it will be clear from what I have related, that two new uses for aluminium have been called into existence for the benefit of industry, both of which rest upon the, as yet, unsuspected property of aluminium as a heat accumulator, whereby it is rendered possible to release in the form of heat, everywhere and with the greatest of ease, the work which was required for the original production of the aluminium. Another thought is not far removed from this, namely, the possibility of using aluminium, not only for the processes described, but to discover a means of turning the heat of combustion of the aluminium back into electricity for the production of power. It is, indeed, possible that in the future the value of aluminium will lie, not altogether in its properties as a metal, but also as a power accumulator of the highest efficiency.

In conclusion, I have to thank Dr. Goldschmidt for the valuable assistance he has given me in the preparation of this paper, and I have also to express once more to him, on behalf of Mr. Cooper and myself, our thanks for the courtesy received at his hands during our visit, and the facilities which he afforded to us for studying his process.

MAXIMITE; A NEW HIGH EXPLOSIVE FOR ARMOR-PIERCING PROJECTILES.

Millions of dollars have been expended by inventors and others during the past 20 years in the endeavor to perfect a gun or projectile by which a shell charged with a high explosive might be thrown at an enemy. Some of these inventors have achieved a considerable degree of success; and such notable experiments in this field as the pneumatic dynamite gun will doubtless occur to the reader. The practical value of all such inventions, however, has been destroyed by the developments which have taken place in high explosives. It is now possible to fill an ordinary shell with a high explosive and fire it from an ordinary rifled gun with entire safety. An example of this which is now of world-wide fame is the Lyddite used in explosive shells by the British army in the Soudan and South African campaigns. It need hardly be said that when high explosives can be thus thrown by ordinary artillery, the inventor proposing special guns or special projectiles to accomplish the same end finds his occupation gone.

For some time past the United States Government has been conducting experiments at the Sandy Hook proving grounds upon high explosives suitable for use as a bursting charge for shells. One of the explosives tested with exceedingly favorable results is termed Maximite. It is the invention of Mr. Hudson Maxim, of Brooklyn, N. Y.

and the accompanying illustrations show the results of some of the tests made with this explosive.

An explosive to be capable of use as a bursting charge in a projectile from a high-power gun must manifestly be highly insensitive to both heat and shock. The Government requires also that the susceptibility of the explosive to chemical change shall be determined by subjecting it to a temperature of 165° F., continued for a period of 15 minutes. The inventor informs us that Maximite may be ignited and will burn like a mass of asphalt, but without explosion. It may be stirred with a white-hot iron rod, or may even have molten cast iron poured upon it without producing explosion.

To determine the resistance of the explosive to shock a small quantity is placed under the hammer of a drop-test machine, and the hammer is let fall upon it from gradually increasing heights. If the material develops sufficient insensitiveness to shock, it is subjected to the crucial test of loading in a projectile which is then fired through a nickel-steel armor plate. In the case of Maximite, a 5-in. shell was thus charged. It passed through the plate and lodged in a sand butt behind, where it was recovered intact. It was then armed with a fuse and exploded. Fig. 1 shows this projectile before and after rupture. The number of fragments into which the projectile was torn was about 800. The original weight of the shell was 45 lbs.

Fig. 2 shows a 12-in. shell before and after the explosion of its charge of Maximite. The number of fragments is estimated at about 7,000. It will be obvious that the power of an explosive is well indicated by the extent to which it pulverizes the shell in which it is confined. Fig. 3 shows a 12-in. shell which was charged with another high explosive and burst under similar conditions. It will be noticed that the fragments are much fewer in number and bear evidence of less violent rupture than the fragments produced by the Maximite. In conducting these tests, small shells are exploded inside a heavy steel chamber; large ones are buried deeply in sand and the fragments are recovered by sifting the sand.

Maximite fuses at a temperature considerably below the boiling point of water. Its resistance to shock appears to be much greater than that of Lyddite. Shells charged with the latter are exploded by contact with armor. Certainly an explosive which will withstand such a shock without detonation should be proof against the shock of firing from a gun, and hence safe from danger of premature explosion while in the barrel of the gun.

There are other considerations, however, which must be taken into account in the projection of high explosives from ordnance. While an explosive may be able to stand the necessary direct shock of acceleration in the gun, still the friction set up between the explosive and the shell, due to the high rotation given it by the rifling of the gun, being at the rate of about 7,000 turns per minute at the muzzle, is often sufficient to ignite the explosive and cause an explosion before the latter has time to fully participate in the rotary movement of the shell. The fusion point of Maximite is so low that on the instant of any heat being produced by friction, the material melts, forming a fluid, and therefore frictionless bearing between the explosive and the shell, upon which the latter may rotate without producing further heat.

It is furthermore necessary to guard against the occurrence of air spaces, where the setback of the explosive in the shell would entrap and compress the air to such a point as to raise its temperature to the ignition point of the explosive. The specific heat of air is very low, and a pressure of but 1,000 pounds to the square inch suddenly applied, will raise the temperature to 1,300° F. Under a pressure of 4,000 pounds to the square inch, which is not at all unfrequently exerted upon the base of the shell by an explosive charge, the temperature would mount to 2,150° F. Maximite possesses the quality of expanding in passing from a fluid to a solid state, the same as water does in freezing. This causes the material to set hard against and adhere firmly to the walls of the projectile, and to fill the entire cavity solidly full, precluding all possibility of entrapped air.

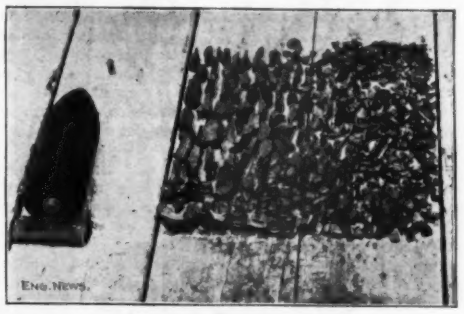


Fig. 1.—5-in. Armor-piercing Shell, Before and After Explosion by Bursting Charge of Maximite.

The composition of Maximite, like most of the high explosives used for ordnance purposes, is kept secret.

We are indebted to Mr. Maxim for the photographs herewith reproduced, and for the information from which the above article has been prepared.

A PROPOSED RESERVOIR SYSTEM FOR THE CONTROL OF THE LOWER MISSISSIPPI RIVER.*

By James A. Seddon, M. Am. Soc. C. E.†

While the Lower Mississippi is practically out of the reach of effects from reservoirs at any of its head waters, still in its natural condition its alluvial valley presented a most striking instance of a great reservoir system of its own. From Cairo down, the area subject to overflow in high waters is about 30,000 sq. miles, or some three times the area of Lake Erie. This, in the main, is formed into a series of great basins. Upon the west bank, from Cairo to Helena, lies the St. Francis basin, while the Yazoo extends from Memphis to Vicksburg on the east. Below the bluffs at Helena, on the west, lies the smaller area known as the White River basin, ending a little below the Arkansas River, where the Tensas basin begins, extending down to Red River. Below the Red River, on the west, the overflow area is known as the Atchafalaya basin, and on the east, from where the bluffs finally leave the river, as the Pontchartrain.

In general, all along these basins, the ground slopes back from the Mississippi into an area of low swamps, threaded with lakes and bayous, and draining into such rivers as the St. Francis and Yazoo. Thus, as the Mississippi rises above the bank-full stage, the flood excess is drawn off into these swamps, which act so far just as a system of great reservoirs. As, however, all the upper basins have their natural drainage back into the Mississippi, it is only above this return that the reservoir action is complete, while at their lower ends they do not hold but only retard the flood excesses that have been drawn off above. This is the natural condition of the Lower Mississippi. However, during the last 15 years the states and government combined have built up a levee system for the protection of these swamp lands, which now entirely shuts out the overflow from all but the upper one of these great basins, and is beginning to seriously restrict it in that.

This levee system leaves open only the large basin on the west, between Cairo and Helena, which is known as the St. Francis basin. From the evidence of the flood of 1897 there is little doubt that to shut off the outflow completely from all these great basins by levees, is to raise the high water stages of such floods from 6 to 8 ft. above the levels at which the natural reservoir system of this river would have carried them; and even in the interests of a real flood protection alone, it would certainly be wise to consider whether some less dangerous step into the unknown might not be substituted for it. This substitute suggests itself at once in the inefficiency of the natural reservoir compared with the one under intelligent control; especially when the extremely low efficiency of this system of swamp reservoirs has been recognized. Two weeks has been noted as about the longest period that these basins would hold back the backflow, and their inflows again form destructive floods at the foot of them. But had the St. Francis basin in 1882 simply been cross leveed at intervals, with outlets under control, making of it a chain of reservoirs to hold this flood water, there would then have been no return flow at Helena, no corresponding outflow into the Yazoo, no inflow crest at Vicksburg; and, while there would still have been some overflow, yet from Memphis down there would have been no great flood that year, and certainly nothing that a very moderate levee system could not safely have carried.

It is true that, in this case, reclaiming the swamp lands in the back of the St. Francis basin would have to be given up, some 4,000 sq. miles as yet unprotected and undeveloped. But this swamp land is not the only land in the valley. All the area that is directly or incidentally drowned out by the complete closure of the great basins is not a small fraction of the 4,000 sq. miles in the St. Francis that would save it. As the first now is mainly farms, while the second is almost wholly swamps, it is a nice question of how much of the one should be sacrificed for the other. But the question does not stand alone. Considering the increasing risk that each additional foot to the high water stages throws upon all the land behind the levees along the whole valley, there is very little doubt that holding the flood waters back, once for all, at the head of the system and never having extreme floods is true flood protection, even if it does sacrifice some 13% of swamp area.

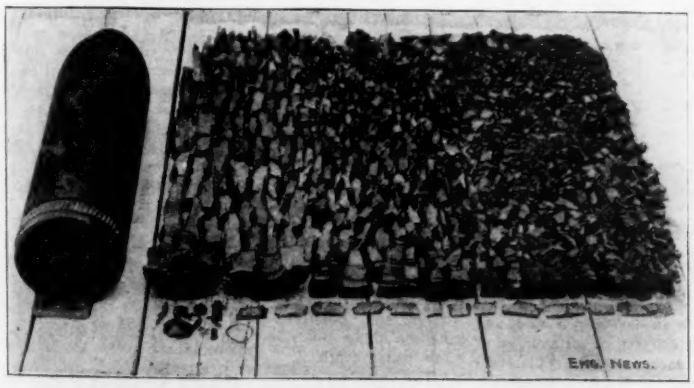


FIG. 2.—12-IN. ARMOR-PIERCING PROJECTILE BEFORE AND AFTER EXPLOSION BY BURSTING CHARGE OF MAXIMITE.

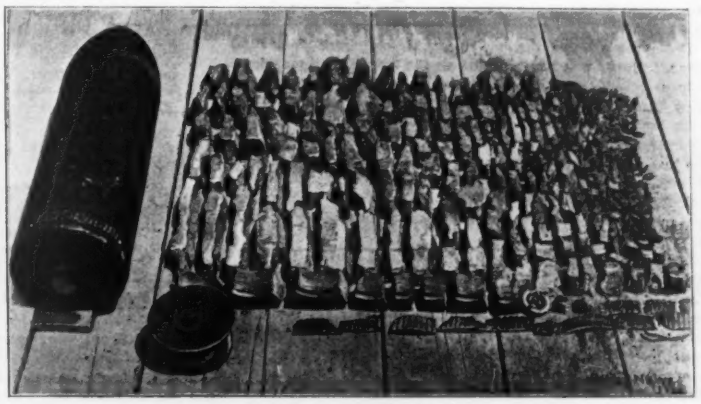


FIG. 3.—12-IN. PROJECTILE BURST BY A CHARGE OF A LESS POWERFUL EXPLOSIVE.

Referring to the flood regimen of 1882, it is seen that a system of cross levees, barring the slope to the south of the St. Francis basin, in all some 120 ft., is simply to take the Memphis flood of that year as the extreme to be passed through to the gulf in the place of the Cairo extreme. There are good reasons for passing the initial flood through to the gulf between levees without any further alternations of outflow and inflow, but to take the Cairo flood for this is to take an extreme discharge of 1,700, in the place of the 1,200 Memphis extreme, or about some 500 greater discharge to drown out the land below which

*From a paper on "Reservoirs and the Control of the Lower Mississippi," presented before the Western Society of Engineers.

†1637 Indiana Ave., Chicago, Ill.

is cut off from levee protection, while greatly increasing the danger to all that is protected.

A levee system with the Memphis flood as the initial one would then pass the high waters at something between the natural extremes found in the course of the unleveed river. Flood volumes would be larger at points of maximum outflow, such as Lake Providence, and less at points of maximum inflow, such as Helena and Vicksburg. The corresponding bed changes would also lie between these extremes, while the grade of the river would not be broken by alternating reaches of excessively increased and reduced discharges.

On the accompanying map of the St. Francis basin such a system of reservoirs is outlined. Of course, no actual location of such a system can be given without a topographical survey of this basin, which has not yet been made. However, enough of its general form is known to fix the type and set the scale of the reservoirs required. Thus, the basin has a more or less uniform tilt to the south, with a total fall of some 120 ft. from Cairo to Helena, as shown in the "sketch of general profile." And, not to exceed the limits of earth embankments, it is seen that a chain of at least some six reservoirs to divide up this fall will be needed here.

Again, the "sketch of general cross-section" shows the lay of the ground from this river across to the bluffs forming the western boundary of this basin, and in this the general type of the reservoirs is clearly indicated. Each should have a levee on the east, limiting the swamp area to be used for this purpose and holding the water in the back or lower portion of the basin. This longitudinal levee begins on grade, taking in the natural drainage from the river to the swamp at its upper extreme, and rises as it goes down with the southern tilt of the basin, till it reaches at its lower extreme the height of the levee that crosses the swamp and closes in the whole reservoir against the high ground on the west.

These lines crossing the swamp would, of course, take advantage of all the high ground that they could follow. They would undoubtedly require heavy work in places, but probably no heavier than some of the front lines on the river already constructed. At the points also selected for the lines of movable dams by which the reservoirs would be filled and emptied, the work would be formed on masonry founded on piles, but in the rest of the line it is thought that earthwork would answer the purpose; or that they would be just what they have been called, cross-levees.

Perhaps, for safety, this should be an especially strong levee, but it does not seem probable that an occasional break here would be any great calamity. It would drain out the reservoir in which it occurred, and would have to be repaired just like a crevasse, but with the provision for rapid filling that the whole system would have, it would seem that it could be drawn off below without endangering the lines following it; while it is only in the event of its occurring just on the top of a great flood that running it out into the Mississippi would make a high water there of any importance.

At the head of this system of reservoirs the outlet for drawing off the flood waters would be located. For this a line of movable dams on the west bank of the Mississippi, just above its junction with the Ohio, would be required. The base of these would be set at about the level of 30 ft. on the Cairo gage, or altogether above the sand movement in the bed of the river; and they should have a range of some 10 or 15 ft. in their adjustable crests, fitting them both to fill the reservoirs from the flood periods of any year, or to draw off the extreme excesses of the occasional great floods.

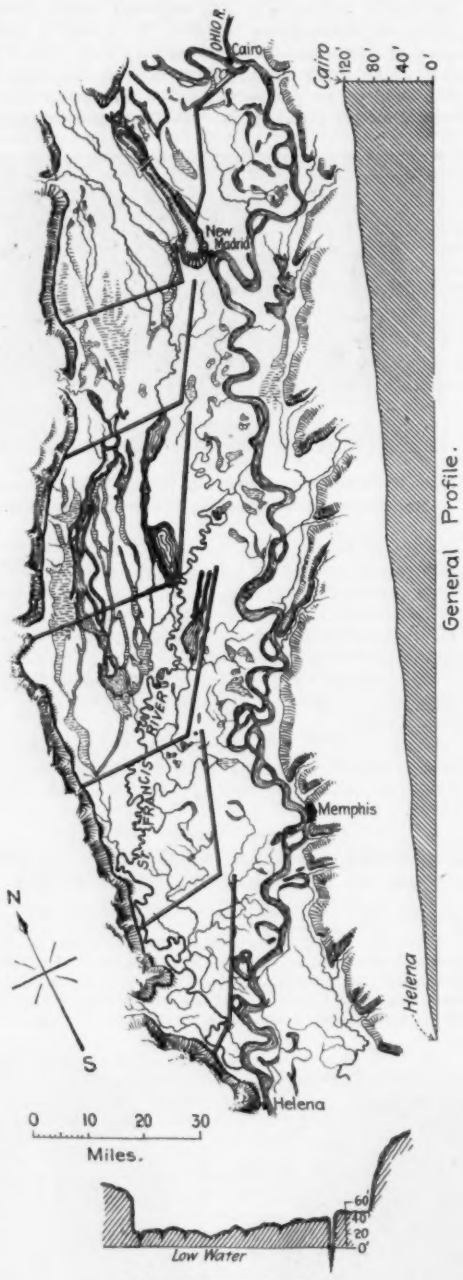
From these dams the outlet would lead back from the river, following some such line as the location shown, first into a double reservoir to the east and the west of the New Madrid high land, and joined by a cut through this high land as indicated. The reservoir on the east would be held between this high land and a line of levees from the outlet down, enclosing such of the swamp lands in the New Madrid basin as might be taken for this purpose. For this reservoir, also, it would be necessary to provide for emptying it back into the Mississippi at low water just above New Madrid.

The one on the west, on the other hand, forms the first in the regular chain of six or more reservoirs extending from Cairo to Helena. These all fill and empty in succession through each other as in the ordinary slack water system of a river. And whatever increase in the navigable depth may be given from Helena down, by emptying the reservoirs on the low waters, it is plain that any navigable depth that may be wanted may be readily carried from Helena up to Cairo through this slack water system. All that is needed is putting in the locks with such dredging, once for all, as the given channels may require.

In the operation of this system of reservoirs it may be noted that the flood at Cairo is generally in sight far enough ahead to know just about what flood water should be drawn off. In the promise of a great flood the plan would be to regulate the crests of the weirs at the head of the outlet so as to hold down the stage to an estimated maximum. With the given capacity, this maximum for the greatest floods would be about the equivalent of a Cairo stage of 42 ft., while correspondingly lower stages would be taken, as there was less and less promise of a great flood.

Even with the fleet of powerful dredges now engaged, the actual improvement to the low water, navigation is necessarily quite limited. With the bars often several miles in length, cutting low water channels through all of them, over the 600 miles of river between Cairo and Vicksburg in this short low water season, is not a task in which any great addition to the depth can be attempted, and perhaps an average of some 2 ft. increase may be taken as its limit. For this an annual expenditure of $200,000 to $300,000 is estimated, including repair of plant and percentage for its renewal.

The cost of the St. Francis reservoir system is now to be considered. Each of the reservoirs may be taken as



Sketch Map of Proposed Reservoir System in the St. Francis Basin of the Mississippi River.

formed of 25 miles of cross levee at $90,000 per mile, and 25 miles of longitudinal levee at $30,000, or an average of $3,000,000 for the earthwork in each of them. This $90,000 per mile will build at average prices a levee altogether heavier than the standard section, safe for some 25 ft. of water against it; while the longitudinal levee is proportioned to run from grade up to it. This estimate, however, takes it simply as team work, while it seems probable that it could be built with hydraulic dredges, in which case it would be at least a third cheaper. In addition, the filling and emptying systems would take an average of some 2,000 ft. of movable dams at $200 per ft., and 2,000 ft. of fixed weirs with flash boards at $150 per ft., or altogether $750,000 to the reservoir, making the total estimate for the six reservoirs $22,500,000.

For the flood-water outlet, the weirs at its head should have some 6,000 ft. of movable dams at $300 per ft., or $1,800,000, while the channel leading back from it would require about 100,000 sq. ft. in the area of its cross section. This, as soon as the grade permitted, should be taken with about one-quarter of its section in cut and three-quarters in embankment, and would be hydraulic dredge work altogether. Probably from $3,000,000 to $4,000,000 would be a full allowance for it, but without a location and levels very little in the way of an estimate can be made of it. A summing up of these items, for the total cost of this reservoir system gives the following:

Six reservoirs, complete	$22,500,000
Outlet, weirs and excavations, say	5,500,000
Land damages, say	4,000,000
Total	$32,000,000

This, however, has not yet considered the development of the system of slack water navigation through the reservoirs from Cairo to Helena. With this a link in a great commercial highway, the locks, of course, should be of ship-canal dimensions and would be large works, costing some $2,000,000 each, or $12,000,000 for the six of them.

Finally, it may be noted that in the last 20 years the government has spent on this river some $40,000,000, or just about the cost of the St. Francis reservoir system with slack-water navigation to Cairo. That it has spent the most of this to pay for experience is now generally admitted; and it may also be admitted that, perhaps, it could not have gotten this experience any cheaper. But, in any event, if the matter was worth beginning it is certainly now worth finishing with such a waterway in sight, carrying as it does this high degree of flood and bank protection with it. The final question then is simply: Having paid $40,000,000 here for experience, does the country now propose to profit by it?

DISCUSSION BY THOS. T JOHNSTON, C. E.

Mr. Seddon's discovery and determination of the physical fact that a system of reservoirs can be located in the St. Francis basin having a capacity sufficient to so materially modify high water conditions south of Cairo, and low water conditions south of Helena, opens the way for projecting other or auxiliary methods for the improvement of the Lower Mississippi, which have not hitherto been the subject of official mention, although, in the light of present facts, entirely worthy thereof.

It was about 1880, or a year of two earlier, that the government entered upon the improvement of the Mississippi River below St. Louis with something like a fixed purpose. Parties were organized and placed in the field in 1878-79 to measure various physical elements of the Mississippi and its main tributaries. Cross-section and its changes, flow of water with its velocities and directions of velocities, water surface elevations, sediment in suspension, topography slopes, and anything else that could be thought of were some of the subjects for measurement, in as many or more different ways as there were subjects and as the ingenuity of the engineers could devise. Overflows attending floods, high and low water conditions and other physical phenomena were investigated. Experimental works of construction were undertaken, in order to learn their utility as river improvement devices. Various engineers were assigned to works at various points, essentially with carte blanche to execute such work as they thought best, and all in an experimental way. Having been identified with these earlier studies for some years the writer knows something of the bewildering mass of data accumulated in the course of several years, and can testify to the seemingly hopeless task of correlating its elements in a way to arrive at tangible information in a form useful for practical application.

The course of procedure adopted, largely forced upon the engineers before investigations and studies could be completed, has been, (a) to prevent overflow into the country adjoining the river by means of levees at or near its immediate banks; (b) the increase, to a very moderate extent, of the navigable depth at a few of the most shallow places by means of dikes, bank revetments and training works; (c) to prevent bank erosion at certain points with sundry purposes in view; (d) and, latterly, to erode annually, by means of hydraulic dredges, temporary channels at the most shallow points along the river. Protection from floods, and a possible navigable depth of ten feet at low water, seem to be the real aims, although a theory has been advanced that by confining the flood waters to the river channel and holding the river to a fixed location the tendency will be to lower the plane of the river, and, possibly, in a general way to equalize the depths along the river and thus increase the navigable low water depth.

The levee construction, (a), has proved to be more of a task than anticipated, as to height, cost of building and cost of maintenance, and many doubt the commercial merits of further endeavor to bring the work to a conclusion. Certainly, it would be highly desirable to substitute some other construction that would accomplish the end in a more satisfactory manner, especially if it would remove the ever present menace of crevassed levees which must have existence if the existing project be carried to a conclusion. The endeavor to improve the navigable depth, (b), at a few stated localities has proved to be expensive tentative work, doubtful as to commercial advantage, and essentially impracticable in any reasonable length of time and at any reasonable expense if made generally applicable to all shallow places. The protection

of banks, (c), from erosion is confessedly impracticable at any reasonable expense and in any reasonable time. The annual erosion of shallow places, (d), in the absence of anything better, is the most promising in commercial utility of any of the elements of the policy of the past. The depth to be obtained is small, however, and, as in the case of levees for flood protection, something better would be highly desirable.

Looked at from any point of view, the results of past efforts for improving the Lower Mississippi are somewhat disappointing though far from discouraging if a broad view be taken of the difficulties that had to be met. It would be highly improper to indulge in criticisms of the course that has been pursued. It is, however, entirely proper to discuss any suggestion giving promise of a better project, especially in view of the tenative nature of all that has been done or that can fairly be anticipated, as indicated by the contrast between the Chicago drainage canal project and the Mississippi River project.

Mr. Seddon's suggestion involves a far more radical protection from flood waters, and a greatly more radical improvement of navigable depth than anything hitherto contemplated, and if it is feasible, with sufficiently definite results to be expected, at anything like the estimated cost, then it would be well worth while to throw away all that has been expended in the past, and take up the suggestion. This is true, even if the results to be hoped for as a consequence of the policy of the past were certain of realization at the estimated cost. No criticism of past methods is involved. It is simply a much better project recently evolved.

The suggestion will, however, bear close investigation before adoption. Only the general and interesting feature of feasibility of storage is announced. Many collateral considerations are involved.

Primarily, there is conflict with the fundamental theory upon which the existing project was based, viz.: "That the river being confined, in all its volume, to a single channel, the tendency will be to lower the plane of the river and generally equalize depths along the river to the end that low water depth will be increased." The converse has been stated, "that a division of the flow of the river will tend to cause the bed of the river to rise and further aggravate the difference in depth along the river." Much has been found in support of this converse by the instance of the division of the flow of the river at the mouth of Red River, where a large flow had existence into the Atchafalaya. However, as Mr. Seddon does not propose the diversion of any great volume, compared with the whole flow of the river, and since, in ordinary years, this flow from the main river will simply be at high flood crest, it is not probable that his idea constitutes any material infraction of the principle of the old theory. Some computations along this line would be interesting and instructive.

Perhaps the most difficult element to be encountered in carrying out this suggestion will be found in the entrainment of the water from the river in the vicinity of Cairo, not so much on account of the excavations and dams to be constructed, as on account of the form the slopes of the river will take during the period of entrainment. Here, again, some figures would be instructive. It may be said, however, that unless the bed or plane of the river be changed, the order of slopes would be affected only during the period of entrainment. At times of extreme flood, when it is desired to lower flood level at Cairo by 10 ft., without a corresponding lowering of level at points upstream in the Ohio and Middle Mississippi, it would seem that there would be a heavy concentration of slope immediately above the junction of the two rivers. The change of velocity of the water due to subtracting the upper 10 ft. of cross-section in the region in question, and running all the water through the smaller sections, would not be great, so that the resistance to flow at any section would not be very greatly increased. The necessary result would be the distribution of this 10 ft. of slope for a greater or less distance upstream—doubtless so far that its influence in an objectionable degree might be essentially nil.

Another difficulty will be met in conducting the operation of entrainment of water at Cairo in different years. The floods of some years do not reach any considerable height, as in 1879, in which instance, in order to fill the reservoirs, Mr. Seddon would have to place his sills lower than contemplated in his paper. This is not serious, however, for proper disposition, to meet these contingencies, in the design of entraining gates and dams can be made. Computations would be instructive here again.

Should Mr. Seddon's suggestion be given application, it may very properly be regarded as an auxiliary to the existing project. That is, work could be continued and maintained along present lines as nearly as practicable, in the light of a flood height at Cairo 10 ft. lower than hitherto.

There cannot, of course, be any question about the feasibility of constructing the reservoirs as suggested, and letting the water out of them in proper form.

The estimates given, though rough and doubtless too low, nevertheless show that the cost of the work is entirely within satisfactory limits. Suppose the results anticipated could be secured at twice the cost, the investment is still meritorious. Looked at from a commercial standpoint, the scheme has one great merit, viz.; the generation making the expenditure will live to enjoy some of its benefits. Ten years would easily suffice for construction. Again, the successful completion of such a project would develop the adjacent country as to usefulness and value to an extent that would be more than equivalent to the acquisition of a Cuba, or the Philippine Islands—and there are many who believe that, like charity, expansion should begin at home.

THE POLLUTION OF PUBLIC WATER SUPPLIES IN THE UNITED STATES.*

The discussion was opened by Mr. Rudolph Hering, M. Am. Soc. C. E., of New York, who pointed out the impossibility of changing habits and customs except by the slow process of education, so that present methods for the purification of water supply must be considered in regard to the existing conditions. There are three methods of treating water preliminary to its filtration: (1) Sedimentation; (2) Precipitation, or the use of chemical precipitants to aid the sedimentation; (3) Coarse straining. As to the various new processes now being introduced and tried, the glowing accounts of their success cannot yet be accepted as reliable for general application. We must consider, in establishing a water supply, proper pressure, proper quantity and proper quality. Regarding the question of quantity, we have a bad reputation in Europe, where we are considered as wasting a very large amount of water. The consumption in our cities is much greater than almost anywhere in Europe. It is hardly understood over there how this can be possible. We here know why this is so. It is not because we actually use very much water that we account for this discrepancy. The chief reason lies in the fact that we are more careless than in Europe. We allow our fixtures to leak and our pipes are not laid as well. Besides, the figures given in reports of water boards do not represent the proper amount of consumption. There is no doubt the waste in consumption may be decreased gradually and brought to something near what it should be. The legitimate consumption here, as in Europe, is constantly increasing. Small manufacuring concerns have increased the consumption of water.

When it is recommended to purify a water supply, there comes the objection of expense, which attends purification works. It is said, Why not reduce the quantity of waste immediately? You can not suddenly change the habits of a people; you can not at once pull up the pipes in a city and make repairs. In the meantime you are obliged in this country, from a political standpoint, to estimate the cost of works to purify these large amounts of water. In New York city 115 gallons of water is allowed per day to each head of population. In Philadelphia 150 gallons per day per head is recommended for filtration. Works put in to meet these conditions (the people in the meanwhile being educated against waste), will last a long time before they will need to be increased.

Mr. John W. Hill, M. Am. Soc. C. E., of Philadelphia, presented a discussion which was practically as follows:

One of the chief obstacles to the more general introduction of works for water purification in the large cities of this country is the high per capita consumption, which in many cases represents an avoidable waste equal to 100% of the actual use and unavoidable waste. The greater part of the avoidable waste is in the plumbing fixtures, and there is no law regulating the character of the brass fittings used. In European cities, where filtration works have been in use in some cases for more than 50 years, and where there is no hesitation in undertaking the purification of the most polluted river waters by plain sand filtration, the consumption ranges from 11 to 53 gallons per capita per day (the higher figure being that of Zurich), and will probably average less than 30 gallons, or one-third to one-seventh of the per capita consumption of large cities in this country. In other words, to purify the water supply of a city in this country requires the construction and maintenance of works three to six times as large as would be required for a corresponding population abroad.

Little known effort has been made to reduce the cost of plain sand filtration by a preliminary treatment of the water other than by sedimentation in large reservoirs. Large subsiding basins are expensive, not only in the land required in large cities, but in the construction of the reservoirs themselves. A rough preliminary filtration will remove a large percentage of the mud and grosser suspended matter from the raw water, so this material has not to be taken out by the sand filters. Thus the cost of purification may be materially reduced, so the combined cost of operation and maintenance and annual fixed charges may be less than that of the generally accepted process of subsidence combined with filtration.

In certain quarters, both here and abroad, it is held and known to be true that when a polluted surface water has been brought by filtration to a degree of limpidity comparing favorably with distilled water, such water is so low in bacteriological contents as to be safe and acceptable for domestic use. Accepting distilled water as a standard, filtered surface water comparing favorably with it when viewed in glass flasks or tubes, under like conditions, may be accepted as potable water in the absence of bacteriological tests.

Since the appointment of Dr. Tharp as official examiner of the water supply of London, no bacteriological tests have been made. The investigations made by Col. A. M. Miller, in charge of the Washington Aqueduct, show that the absence of turbidity is accompanied by a substantially corresponding absence of bacteria in the filtrate. It must be understood that if there should be any objection to a surface water by reason of its mineral constituents in solution, filtration will probably have little influence upon any of these except the dissolved iron.

An attempt at the present time to supply a filtered surface water absolutely free from disease germs and wholly innocuous to health would be accompanied by a cost which would prohibit its use on a large scale for water supply. On the other hand, with a rigid curtailment of the avoidable waste in large cities, the cost of constructing and operating works for water purification will come within the reach of any city which really desires to cultivate the public health, so far as this may be influenced by the water supply.

Mr. F. A. W. Davis, Superintendent of the Indianapolis Water Co., also discussed the report. He remarked that while the report called attention to the advancement in methods of purification of water, it did not, in his judgment, sufficiently emphasize the importance of keeping the streams from which the supply must be taken from being polluted. Water purveyors agree with the committee, but they believe that an ounce of prevention is worth a pound of cure. It is expecting too much of the water purveyors to ask them to furnish an ideal water when the city and manufacturers throw into the streams from which the supply is obtained material containing disease germs.

Mr. H. W. Clark, Chief Chemist of the Massachusetts State Board of Health, spoke of the growing necessity of purifying water from existing sources of supply. The city of Springfield, Mass., which obtains its water from a reservoir, proposed taking an entirely new supply from a river some 20 miles from the reservoir. The State Board held, however, that the water of the river practically belonged to the people in that section of the state, and that the city of Springfield should turn its attention to purifying the adequate supply which it already has.

The discrepancy in the analyses of sewage given in the report is due largely to lack of care in taking the samples, and this is particularly the case in regard to Framingham, which makes such an unfavorable showing in the report. If men of no skill or training are employed to attend to the distribution of the sewage upon the beds, they are likely to forget or neglect their duty at times, with the result of giving the beds unduly large doses. With rapid filtration, the larger the area the less perfect are the results, and the same is true of septic tanks. It cannot yet be said that either of these systems will prove satisfactory on a large scale.

Mr. Snow referred to a plant now being built for sewage disposal at Mansfield, O. The city has the combined system of sewerage, and at times part of the storm water will have to be dealt with by the purification plant. For practical purposes, it is important to determine what degree of purification of water is necessary, and what degree of pollution is permissible. The serious loss and delay caused by opposition to sewage disposal plants has led the Ohio legislature to now require a vote of only half instead of two-thirds of the population affected as requisite for ordering the establishment of a proposed plant. One trouble is the desire for cheapness, for if a proper plant will cost $50,000, people always think it ought to cost but about $10,000.

*Discussion of a Report of a Committee of the American Public Health Association, presented at the Indianapolis meeting, Oct. 24, 1900. The full report was published in our issue of Oct. 25.

FAST RUNS ON THE LEHIGH VALLEY R. R. have been tabulated by Mr. Chas. S. Fee, General Passenger Agent, and are given below. These fast runs were made by the "Black Diamond" express train, running between Buffalo and Jersey City, 447 miles; the schedule running time eastward being 9 hours and 20 minutes (560 minutes), and westward, 9 hours and 12 minutes (552 minutes). The table is made for the special fast runs noted between October, 1897, and July, 1900:

Date.	From	To	Distance, mis.	Actual time, hr., mins.	Sp'd per mins. mls.
Distances over 100 Miles.					
July 20,'98.	Sayre	Buffalo	177	169	63
July 24,'99.	Sayre	Buffalo	177	170	62
Distances 50 to 100 Miles.					
Oct. 11,'97.	Easton	So. Plainfield.	50.4	48	64
Oct. 16,	Easton	Parkview	65.6	60	66
June 6,'98.	Easton	Parkview	65.6	61	62
Jan. 9,'99.	Manchester	Buffalo	88	86	61
Mar. 22,	Manchester	Buffalo	88	85	62
Mar. 23,	Buffalo	Manchester	88	83	64
Nov. 2,	Wende	Manchester	69	61	65
Distances under 50 Miles.					
May 15,'99.	S. Somerville.	Landsdown	19.5	16	73
May 20,	Laceyville	Rummerfield.	18.9	14	82
June 24,	Wysox	Wyalusing	16.8	14	73
July 18,	Laceyville	Wysox	26	22	72
Aug. 19,	Laceyville	Homet's Ferry	15	12	75
Oct. 13,	Rummerfield	Laceyville	18.9	15	76
Nov. 3,	Alpine	Geneva Junctn	43.9	33	80
Feb. 12,'00.	Hinman	Geneva Junctn	44.9	37	73
Feb. 19,	Alpine	Kendaia	34	25	82
Mar. 22,	Batavia	Depew Junctn.	27.5	23	70
July 3,	Homet's Ferry.	Laceyville	15	12	75
July 21,	Alpine	Kendaia	34	23	89
Oct. 5,'97.	Musconetcong.	Three Bridges.	15.4	12	77
Oct. 9,	Three Bridges.	Bound Brook.	15.5	11	85
Oct. 13,	Homet's Ferry.	Laceyville.	15	11	82
Oct. 16,	Wyalusing	Wysox	16.8	13	78
Oct. 18,	Pt. Reading.	Landsdown	21.9	18	71
Oct. 21,	Musconetcong.	Bound Brook.	30.9	26	71
Nov. 1,	Wyalusing	Wysox	16.8	14	72
Nov. 11,	Hector	Kendaia	17.6	12	88
Dec. 11,	Towanda	Laceyville	30	25	72
June 9,'98.	Parkview	So. Plainfield.	15.2	14	66
Jan. 13,	Musconetcong.	Three Bridges.	15.4	13	66
Aug. 6,	S. Somerville.	Landsdown	19.5	17	69
Aug. 9,	Parkview	So. Plainfield.	15.2	13	70
Aug. 31,	So. Plainfield.	Parkview	15.2	13	70
Oct. 3,	Budett	Kendaia	22.9	17	82
Oct. 17,	Alpine	Kendaia	34	26	79
Dec. 16,	Laceyville	Rummerfield.	18.9	15	76

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CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXI-XXIII. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

The suggestion in this column two weeks ago that engineering schools were perhaps devoting too much time to the study of the higher mathematics, has drawn out several interesting letters in reply, some of which we printed last week, and others appear in our correspondence column in the present issue. These letters show, first, a misunderstanding of our position as expressed in the editorial above referred to, and, second, a real difference of opinion as to the value of the higher mathematical training and the extent to which it ought to be pursued in the engineering schools.

To clear up first the misunderstanding: It appears to have been supposed by some correspondents that we were arguing in favor of more practice and less theory, and more specialization and less of general scientific study in the engineering schools. But this is exactly contrary to our real position. We heartily agree with the position of Prof. French—which is, we are sure, in accord with the opinions of all leading engineering educators—that the main object of the engineering school should be to ground its pupils thoroughly in the science of engineering, as distinguished from engineering practice. Make sure of the "why" first, and then give as much of the "how" as time permits. Our criticism two weeks ago was directed rather at the use of mathematical formulas as working methods, not as shortened expressions of the reasoning on which the process is based, which reasoning ought by all means to be fixed in the student's mind.

In our opinion there has been and is still too much of a tendency toward specialization in engineering schools; but we are aware that it has been in a measure forced upon the engineering instructors in many cases by the public demand for "more practice and less theory," a demand which often comes in a shape that compels compliance, even against the better judgment of the instructors. With this explanation it ought to be clear that we have not and do not argue for a lower standard in our engineering schools, but a higher one. We do not favor instruction in the art at the expense of the science. To do this is to weaken the foundation for the sake of adding to the superstructure.

Having made clear our position in this respect, let us now turn our attention to matters on which a real difference of opinion appears to exist, viz., our remark, which we doubt not sounded heretical to many, that "we have sometimes wondered whether the time spent on the higher mathematics in the engineering schools did not result in more harm than good to the reasoning powers of the average student." It was Prof. Merriman, if our recollection rightfully serves, who said a few years ago, "Mathematics too often beclouds the mind whose tool it is." Every engineering instructor, we are sure, must have had in his classes students to whom proficiency in mathematics was never attainable, and who yet were hard workers, and by no means mentally incompetent in other branches of study. At the other extreme are those gifted by nature with special mathematical ability, and between these are the mass of students with average all-around powers. Now, the question comes, does it or does it not tend to the best education of all these men to put them all through the drill in higher mathematical work which is part of the set course in practically all engineering schools? Does not experience show that these men to whom mathematical studies are irksome and difficult not infrequently become the ablest engineers?

We may be wrong, but it has seemed to us that a noticeable tendency was discernible among engineers of the present day to try to solve engineering problems by mathematical processes, and to cling so closely to the process and neglect so much the physical facts on which the problem is based that serious errors would creep in and pass undetected.

Take physics or mechanics, for example. The student ought to have the fundamental facts in these studies fixed in his mind and thoroughly comprehended, so that he can always go back to them and know that his work is based on a firm foundation. But over-much work with formulas in these studies tends to fix some algebraic abstraction in his mind instead of the concrete facts on which it is based.

As we have already said, it makes a great difference how a given study is taught. We doubt not that in many of the leading engineering schools great pains is being taken to make clear to the students the real meaning of the problems in analytical mechanics and to invest even the dry bones of calculus with something akin to life. But we are almost equally sure that in other schools a large proportion of the students are squeezing through these studies with a "pass" marking and with little clear idea as to their object and aim.

We hear, however, the old argument that these studies are valuable as a "mental gymnastic." Perhaps so, but we are heretical enough to believe that it is a form of gymnastic which too frequently benefits little if at all many of those who attempt its performance. In our opinion, physics and chemistry, especially the former, are the most important of all the studies which the engineering student pursues. Much better instruction is given in these branches, we are sure, than was given fifteen or twenty years ago; but we question if even yet these studies are rated where they should be in comparison with mathematical training. We do not mean by this that engineering students ought to be made adepts in the conduct of work in either the physical or chemical laboratory. That again is of secondary importance, except as it may serve to fix in their minds the fundamental physical laws to which their work must conform if it is to stand.

We doubt not that some of our critics are saying that mechanics is but a more highly developed form of one branch of physics; and to this we reply that with mechanics taught as a physical, concrete reality we have no quarrel. We protest against the tendency toward reducing these living facts to a mathematical abstraction, which many students fail to grasp.

Finally, in reply to those who have insisted that we have been unjust to the engineering schools we would quote from the admirable address of Prof. Merriman, delivered before the Society for the Promotion of Engineering Education, in 1896:*

> Probably it (the more thorough teaching of mathematics) cannot be satisfactorily accomplished until a change of method has been effected. The fundamental element in this change of method must be, it seems to me, a partial abolition of the formal logic of the text books and the introduction of historical and utilitarian ideas. Mathematics is a tool, to be studied for its uses rather than for its logic or for the discipline that it can give. . . . Probably less improvement has resulted in the teaching of rational mechanics during the past quarter of a century than in any other subject. That mechanics is an experimental science whose laws are founded on observation and experience is often forgotten and the formal logic of the text books tends to give students the impression that it is a subsidiary branch of mathematics. . . . Physics is a fundamental subject, whose principles and results are of constant application in every walk of life, and a student who thoroughly covers a well-arranged course has gained a mental discipline and a scientific habit of mind that will be of greater value than the technical details of a purely engineering specialty.

Sound doctrine and admirably expressed! Our own utterance sounded more radical, doubtless, but radical utterance forms often the main basis for charges of heresy; and we are strongly inclined to believe that the views we have expressed, if rightfully understood, are not so far from those held by many progressive engineering educators.

A NEW PLAN FOR CONTROLLING THE LOWER MISSISSIPPI.

One of the most notable contributions to the problem of the control of the Mississippi River that has been made in a long time is a paper by Mr. Jas. A. Seddon, which was recently read before the Western Society of Engineers, and which we have reprinted in much condensed form elsewhere in this issue.

The complete paper of Mr. Seddon, with the discussions upon it, occupies over 60 pages in the August number of the "Journal of the Western Society of Engineers," and is an able and exhaustive presentation of a most important engineering problem. The abstract which we give, however, will enable our readers to gain a fair idea of the proposition which Mr. Seddon makes.†

It is in brief that in what is known as the St. Francis Basin of the Lower Mississippi (a tract of low-lying land, in southeastern Missouri and northeastern Arkansas), a series of shallow reservoirs should be made, into which the flood flow of the Mississippi at Cairo could be diverted at times of high water. In these reservoirs the surplus waters would be stored until the season of low water in the Mississippi, when it would be turned back to the river to raise its level and aid navigation during the season when it is impeded by the shallow depth.

These reservoirs are planned to cover an area of some 4,000 sq. miles, with an average depth, between high and low level, of 15½ ft. On this basis they would have a capacity equal to the entire maximum discharge of the Mississippi at Cairo during the flood of 1897 for a period of 13 days. In comparison with them, all other artificial reservoirs ever undertaken by man are of trifling size. The body of water stored, for example, would be over 200 times as great a volume as that which will be impounded by the great Wachusett dam in eastern Massachusetts, described in our issue of Sept. 13. The area proposed to be covered by these reservoirs would be, in fact, nearly half as large as the entire state of Massachusetts.

To carry out this great work Mr. Seddon estimates that some $32,000,000 would be required, including in this, besides the cost of the necessary levees, dams, and retaining walls, the cost of the land which would have to be overflowed. Besides this he proposes that these reservoirs should be utilized as a system of slackwater navigation through which steamboats would pass

*Eng. News, Aug. 26, 1896, p. 118.

†If any of our readers desire to obtain Mr. Seddon's paper with the discussion in full, we may note that it has been reprinted by the Illinois River Valley Association and copies can be obtained by addressing the Secretary, Mr. R. R. Bourland, Peoria, Ill.

from Helena to Cairo during the season of low water in the Mississippi. This, he estimates, would increase the total cost of the enterprise to some $44,000,000.

Further details of the scheme are given in our abstract of Mr. Seddon's paper; and we may add that it has attracted considerable attention in the newspaper press, and it is not unlikely that it may be further heard from when the question of Government work upon the Mississippi again comes before Congress.

The first comment to be made upon this project is that it is based to a very large degree on conjectures which could only be made certainties by an extended topographical survey. This is not an argument against the project. It simply means that at its present stage it is a scheme and nothing more. If Mr. Seddon's general ideas of the topographical conditions in the region he proposes to inundate are correct, his scheme may be or may not be a good one; but at the outset these unknown conditions must be determined before its definite adoption can be seriously considered.

The argument in favor of the project is so ably presented by its author that we need say little on that aspect of the case. It is undoubtedly true, as Mr. Seddon points out, that the complete closure of the St. Francis basin by a levee system so high and strong as to confine all the flood waters of the Mississippi which pass in front of it, will raise the flood heights for a long distance down the river and necessitate the raising and reconstruction of a large part of the existing levees. This question was ably discussed by Major Wm. Starling in his valuable papers on the floods of the Mississippi, printed in Engineering News in 1897, and afterward published separately. On the other hand, the magnitude and cost of this work can be estimated with considerable accuracy; and it possesses fewer elements of uncertainty than Mr. Seddon's ambitious project.

What appears to be a marked defect in Mr. Seddon's estimate of the cost of his project is his allowance for the cost of land damages. This he puts at $4,000,000, for the 4,000 sq. miles to be appropriated, of which, he says, about one-third is now water, this makes the average price for the land overflowed about 2⅓ dollars per acre. Mr. Seddon himself admits, however, that this very low figure is only admissible because the land is now subject to overflow. With a levee protection along the Mississippi water front, this value will certainly rise. In fact, he explicitly states that this is the case and urges that the land should be condemned and appropriated by the Government before its value becomes enhanced by the levee construction.

This might be a correct method of procedure if a private enterprise were concerned; but the Government must look at the question in a broader light. This great tract, half as large as the state of Massachusetts, although now almost useless, may, let us assume, by proper drainage and flood protection be converted into farms as fertile as those in other parts of the Mississippi bottoms. If this can be done, its average value will be many times the sum per acre which Mr. Seddon assumes; and if this is the case, it is this potential value and not the present value of the land that should be considered in comparing the levee system and Mr. Seddon's reservoir plan.

To defend the permanent flooding of this great region, Mr. Seddon argues that the reduction of flood heights will lessen the area flooded by backwater in the basins farther south in the Mississippi valley, so that the net amount of land lost to cultivation will not be so great after all. It appears to us that a fallacy is involved in this comparison. The land which is flooded by backwater in the Mississippi valley is not ruined by any means. It is overflowed for perhaps one to half a dozen weeks, some of it every year and some at intervals of three or four years; but there is usually time to raise a crop from it even in a flood year, and in seasons of ordinary high water a large part of it is not overflowed at all. The land in Mr. Seddon's reservoirs, however, would be under water the whole year (except when the reservoirs were emptied during the winter), and would of course be an absolute loss to cultivation.

Again, Mr. Seddon's comparison of the cost of his own system and the levee system appears to us hardly sound. He says of the levee system:

> In the last 20 years, the Government has spent on this river some $40,000,000. . . . That it has spent the most of this to pay for experience is now generally admitted.

We hardly think the owners of the land behind the levees on the lower Mississippi would admit any such proposition. If our understanding of the case is correct, the present levee system, admittedly imperfect and too low to give protection against the very high water of extreme flood years, is yet believed to have been of sufficient benefit already to compensate for the expenditure upon it. These Mississippi bottom lands are famous for their fertility. The fact that the cost of the present levees has been to a large extent raised by the local and voluntary taxation of the land owners would appear to be prima facie evidence of their value.

Moreover, this levee system would still be necessary even were Mr. Seddon's scheme carried out. All his reservoirs could do would be to cut off the top of the floods. The river would still rise against the present levees, though not to overtop them.

The real comparison to be made then, it seems to us, is between the total cost of raising the present levees and making them high enough and strong enough to hold the maximum floods when the St. Francis basin is closed and the cost of carrying out Mr. Seddon's plan.

Now, Mr. Seddon's own estimate of the cost of completing the present levee system is only $20,000,000, or $12,000,000 less than his estimate of the cost of his own project, not including in the latter the slack-water navigation scheme. He estimates besides this, it is true, $2,000,000 per annum for maintaining the levee system; but as we have already seen, this must be maintained in any event, and he has not estimated at all the cost of maintaining his own system, with its 300 miles of earth embankments, built practically like levees but required to do service all the year and every year.

This part of Mr. Seddon's project, indeed, merits more extended comment. We need not point out to engineers the difficulties and dangers involved in the construction and maintenance of such an enormous extent of earth embankments, all of them founded on an alluvial formation and subjected to all the uncertainties of settling foundations, porous layers in the soil, boring crawfishes and other forms of water life. Experience with earth reservoir embankments and dams, to say nothing of levees, has shown that there are always more or less uncertainties and a certain percentage of failures, even when good foundations and selected soils can be had. The embankments for these proposed huge reservoirs, however, must be built on such foundation as is available and with such soil as the immediate locality supplies.

Let us appreciate exactly what Mr. Seddon proposes to construct: Referring to his map, we see six great artificial lakes, averaging nearly 700 sq. miles in area, each of them lying some 15 ft. above its neighbor next below, and separated from it only by a narrow artificial earth embankment, about 50 miles long. Suppose all these reservoirs are full and a break occurs in this line of embankment, say in the one confining the highest reservoir in the series.

Mr. Seddon, in his paper, alludes to this possibility, and says:

> It does not seem probable that an occasional break here would be any great calamity. It would drain out the reservoir in which it occurred and would have to be repaired just like a crevasse, but with the provision for rapid filling that the whole system would have, it would seem that it could be drawn off below without endangering the lines following it, while it is only in the event of its occurring just on the top of a great flood, that running it out into the Mississippi would make a high water there of any importance.

We are unable to take so sanguine a view of the sequence of events. A break in an earth embankment with 15 ft. head of water behind it, and no solid foundation beneath it would be very apt, it seems to us, to spread and deepen, and send out a volume of water which it would be beyond the power of waste weirs or movable dams in the reservoir below to handle. If this were the case, the reservoir below would be overtopped all along the line and the disastrous consequences of the overflow of an earth embankment are well known to every hydraulic engineer. The third reservoir in the series would then fill with still greater rapidity and so the destruction would continue. It is perhaps true that if there were no flood on the Mississippi channel could take the discharge at the lower end without serious harm; but how much would be left of the $18,000,000 investment in reservoir embankments when their contents had discharged? It will be conceded, of course, that if such a disaster as we have outlined is a probable or even possible outcome of Mr. Seddon's project, it is not fit for serious consideration.

Much has been said by way of comment upon this project with respect to its possibilities in the direction of internal navigation. It is, in fact, because of this feature that certain interests in Chicago and St. Louis have taken it up and are trying to push it into public attention. Manifestly, however, unless the proposed system could be made reasonably secure against breaks and floods, it could be of no practical use as an inland navigation route. A break in a single reservoir, which Mr. Seddon admits to be quite possible, even if it did not wreck the reservoirs below, might leave a dozen steamboats high and dry and would put the whole navigation route out of use until the next season of high water gave an opportunity to refill the basin.

The above are a few of the reasons why Mr. Seddon's project, ingenious though it is, appears to be impracticable, both from the financial and the engineering standpoints. At the least it must be admitted, even by those who have espoused the project, that these objections must be fairly met, and the whole plan must be established on a complete knowledge of physical conditions and on sound engineering practice before its adoption by the National government could be recommended.

LETTERS TO THE EDITOR.

The Reno Inclined Elevator.—Correction.

Sir: In your issue of Oct. 18, 1900, under the heading "A New Moving Stairway," you state that the Reno Inclined Elevator is built at a smaller angle of elevation than the machine particularly described in the article referred to, thus taking up more room; that it moves at a slower rate of speed and that at the station of the Elevated Railway in this city, at which it is in use, many people walk upstairs in preference to using the elevator, being thus able to ascend more rapidly to the station. We beg to call your attention to the facts in the case that you may correct the error made in printing the above statements. In the first place, our elevators are built at an angle of 25°. Fig. 1 (diagram elevation of Link Belt Moving Stairway), in article referred to, shows that truss to be built at the same angle, though the angle claimed is 26°; consequently our structure is no flatter nor does it take up any more room. Second, the minimum speed at which our elevators run is 90 ft. a minute, the best rate of speed claimed by the builders of the stairway; the majority of the 16 elevators built by us run at an average rate of speed of 100 ft. a minute and several of them run at or above 120 ft. a minute, so running faster than the machine described. As a matter of fact, walking with an effort, a person who does so will find himself at least 8 ft. in the rear of one who rides on our elevator at 59th St. and Third Ave. We also find that that elevator is used by 85% of the patrons of the road at the station at which it is operated.

We do not wish to enter into any controversy relative to the merits or demerits of either any inclined elevator or moving stairway. We are satisfied to stand on our record. We do wish and so request that erroneous statements, involuntarily made we know, prejudicial to us, be corrected through the same medium from which they originated.

Very truly yours, J. W. Reno.

141 Broadway, New York, Oct. 24, 1900.

(We give space with pleasure to the above corrections. The member of our staff who prepared the article above referred to gained his impressions regarding Mr. Reno's machine at the Paris Exposition, where all the machines of this type exhibited are set at a very flat angle and are run at slow speed. This was very likely due, however, to the requirements of the Exposition authorities. Experience in the United States evidently proves that much steeper grades and higher speeds are entirely safe.—Ed.)

A Scheme for Measuring the Bulges in a Wall—Engineering or What?

Sir: Some time ago while looking after things mechanical at a plant for the production of malleable iron castings, a piece of work came to my notice which, although it attracted no particular attention at the time, has since then made me wonder whether it was "a piece of engineering," or what it was.

It was done by a young fellow who came to us with no special recommendation except that the treasurer of the company knew who he was, and we needed an assistant to our regular draftsman. He was hired and shortly afterward forgotten, so his work must have been satisfactory. We had an annealing house, 165 ft. × 70 ft. The walls were 30 ft. high, of brick, with pilasters 15 ft. apart, and shortly after erection, owing to the intense heat of the annealing ovens and the poor foundation afforded by "made ground," they began to bulge. They were braced and soon afterward measured and a diagram was made

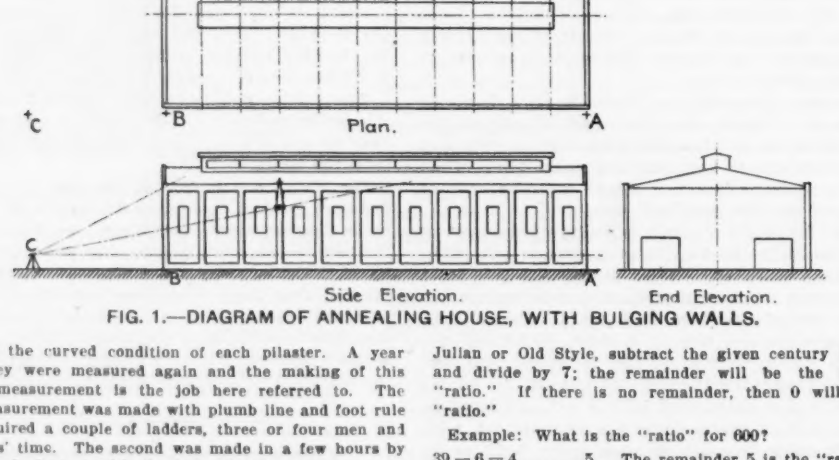


FIG. 1.—DIAGRAM OF ANNEALING HOUSE, WITH BULGING WALLS.

showing the curved condition of each pilaster. A year later they were measured again and the making of this second measurement is the job here referred to. The first measurement was made with plumb line and foot rule and required a couple of ladders, three or four men and two days' time. The second was made in a few hours by our new draftsman with the help of a boy and appeared novel enough to be interesting.

Fig. 1 shows the annealing house. He first set up a transit at A, a point on the ground about two feet from the base of the brickwork and sighted on B, also two feet from the wall, and then projected the line to C and marked that point on the ground. The instrument was then set up on C and sighted back at A and B and locked in the horizontal plane while vertically it commanded the entire surface of the wall.

Next the boy, who was acting as rodman, went to the roof with a contrivance that would have had trouble to get a place in a catalogue of surveyor's instruments, but it evidently did the work in this case and paid for itself. As shown in Fig. 2, it was an ordinary levelling rod with the target and extension piece removed and the bottom end fitted into a hole through the center of a piece of board about 10 × 24 ins. There were four lines of common

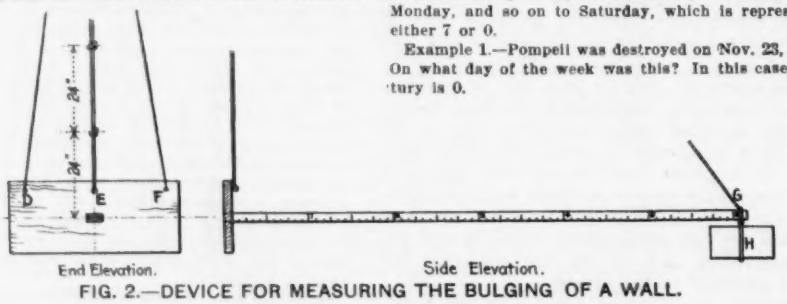


FIG. 2.—DEVICE FOR MEASURING THE BULGING OF A WALL.

tar rope fastened, one each at D, E, F and G, the one at E being knotted every 2 ft. from the rod. This outfit was lowered from the roof with the board flat against the pilaster and the rod perpendicular to it. The rope at G kept the rod horizontal and H was a weight (two bricks) to hold it firmly to the wall and prevent it from swaying with the wind. The lines to D and F served to turn the board and keep the figures on the rod exposed to the line of sight from the instrument.

The board was lowered over each pilaster, stopped every 2 ft., as marked by the knotted cord, and a reading taken from the instrument. The telescope showed the figures plainly and the man at the instrument kept the notes. By going down one pilaster and up the next the whole wall was covered in a short space of time. A sort of a vertical levelling job. Fig. 1 shows the rod part way up the fourth pilaster. The results checked accurately with the previous survey, but it is odd how differently two men will do the same job.

C. F. S.

Oct. 18, 1900.

To Find the Day of the Week Corresponding to Any Date.

Sir: The methods described below will be found very convenient for telling the day of the week corresponding to any given date, from the Christian era to 3900 A. D.

MONTHLY "RATIO."

Jan.	Feb.	Mar.	Apr.
1	4	4	0
May	**June**	**July**	**Aug.**
2	5	0	3
Sept.	**Oct.**	**Nov.**	**Dec.**
6	1	4	6

Here are twelve digits, each of which represents the "ratio" of a month, taken consecutively in the horizontal line; 1 for Jan., 4 for Feb., 4 for March, and so on. For leap year, deduct 1 from the ratio of Jan. and Feb. These numbers should be memorized in the order given.

CENTURY "RATIO."

To find the "ratio" for any given century: For the Julian or Old Style, subtract the given century from 39 and divide by 7; the remainder will be the required "ratio." If there is no remainder, then 0 will be the "ratio."

Example: What is the "ratio" for 600?

$39 - 6 = 4$ ..... 5. The remainder 5 is the "ratio" for 600.

7

To find the "ratio" for any century for the Gregorian or New Style: Subtract the given century from 39 and divide by 4. Double the remainder will be the required "ratio."

Example: What is the "ratio" for 1700?

$39 - 17 = 5$ ..... 2. Double the remainder 2 and we have 4, the required "ratio."

4

TO DETERMINE THE DAY OF THE WEEK CORRESPONDING TO A GIVEN DATE: RULE—Add together the odd years and one-fourth of the odd years, discarding fractions, the date of the month, the "ratio" of the month and the "ratio" of the century. Divide the sum by 7. The remainder will be the number of the day of the week, as numbered by the Quakers—that is, 1 for Sunday, 2 for Monday, and so on to Saturday, which is represented by either 7 or 0.

Example 1.—Pompeii was destroyed on Nov. 23, A. D. 79. On what day of the week was this? In this case the century is 0.

Odd years	79
¼ of the odd years, discarding fraction	19
Date	23
Ratio for November	4
Ratio for 0 century (O. S.)	4
	7)129
	18..3

Here the remainder, 3, stands for the 3d day of the week, or Tuesday.

Example 2.—Columbus discovered America on Oct. 12, 1492. What day of the week was this?

Odd years	92
¼ of the odd years	23
Date	12
Ratio of October	1
Ratio for 1400 (O. S.)	4
	7)132
	18. .6 = Friday.

Example 3.—What day of the week was July 4, 1900?

Odd years	00
¼ of odd years	0
Date	4
Ratio for July	0
Ratio for 1900 (N. S.)	0
	4 = Wednesday.

Pope Gregory XIII. promulgated the New Style in 1582. England and her colonies adopted the New Style in 1752. Russia still adheres to the Old Style and is now 13 days behind.

John Waterhouse.

71 Broadway, N. Y., Oct. 15, 1900.

Mathematical Work in Engineering Schools.

Sir: The editorial in your issue of Oct. 18, which treats of practical methods in engineering work and of the ignorance of such methods by graduates of engineering schools, raises the question which is uppermost in the minds of many engineering teachers: How far shall the school go in an attempt to teach engineering as an art rather than a science?

Granted that the instructor has had considerable engineering practice before attempting the duties of a teacher and has a practical mind, which is not greatly in love with mathematical gymnastics, is he not in danger of teaching the "how" rather than the "why" of certain routine operations? For instance, with the slope tape and rod given to a class who are setting slope stakes for the first time, does the finding of the same reading on rod and tape offer the exercise he most needs?

I can see no reason for fussing with formulas for slope stakes. With little talk about the matter in class room, go out and set stakes. A half-hour will clear all the mystery away and the remainder of the day's work stands for training the eye to judge the ground, and the brain to do quick figuring. At the end of such an exercise the quickest and cheapest method, mechanical or otherwise, should be brought to the student's attention and should become a part of his notes.

The writer once made the mistake of putting before the class at too early a date the valuable tables and diagrams for selecting required beams, columns and shapes. The result was that the students, depending upon such aids, could not handle the proper formulas for odd or special sections. A certain amount of repetition in the use of the simple formulas seems to be necessary that the form and significance of the formulas shall be impressed upon the mind. After this use of the theory should come the knowledge and use of all available time and labor-saving devices, but too often the time available for a subject has been exhausted. That the student may not be ignorant of the practical ways of turning off work, the writer makes a liberal use of such valuable articles as appear in your journal and other engineering literature, by having references to such articles written on the card which outlines the work of the day upon which it seems best to bring the short-cut to the attention of the class.

This method would seem to combine the advantages of a training in the use of the usual formulas, which enable the engineer to handle a small bit of work without special equipment, and a knowledge of better methods which he will be sure to use if the magnitude of the work demands it.

The teachers are struggling with the problem of graduating men who shall be well grounded in the theory underlying engineering operations, and who shall at the same time be prepared to quickly adopt the practical methods of obtaining the greatest results for the least expenditure of time and money. All the aid that the practical engineer can give, by publication of his methods, are welcomed by the schools and should aid in producing young men who shall become engineers in the best and highest sense of the term.

Yours truly,

A. W. French.

Worcester Polytechnic Institute, Worcester, Mass., Oct. 23, 1900.

Sir: In an editorial in your issue of Oct. 18 you say: "But we have sometimes wondered whether the time spent on the higher mathematics in our engineering schools did not result in more harm than good to the reasoning powers of the average student," and in your issue of Oct. 25 in a rejoinder to Prof. Johnson's letter, you say: "As for our final criticism—that there is still too large a proportion of the students' effort devoted to mathematical gymnastics in our engineering schools, in comparison with the time given to other departments of study—we find no specific contradiction of this in Prof. Johnson's letter." It's a pity to see such thoughts as these in a journal of the character of Engineering News. I do not intend to disprove such statements—the time has gone by when it is necessary. During an experience of 25 years as a teacher, in all which time I have also been practicing my profession as an engineer, I have met and known intimately many of the greatest engineers of this (or any) country. It has been my business to talk with many of them on this subject. All who have had the "higher mathematical" education say: "Keep the theoretic standard high." All who have not had it have deplored their loss. I read your editorial and had no intention of writing you until I saw your rejoinder to Prof. Johnson. I then thought it my duty on behalf of sound engineering to

protest against such opinions as you expressed. In the state of engineering knowledge now and hereafter any one who has not in some way obtained the higher mathematical training must accept and use without understanding the results of men better trained than himself. He must follow. It is of course a fact that in the ordinary daily operation of most engineers the "higher mathematics" are less used than the "lower," but this does not in any way alter the correctness of the position taken above. And my right of protest is rendered stronger by the fact that our school has been the one, above all others, which has most vigorously protested against the tendency in modern engineering education to accept students badly prepared in secondary schools in the lower mathematics and put them, still badly prepared, through the higher mathematics. The "slope stake" part of your editorial is a minor matter, though I think that in it you do injustice to teachers in engineering schools generally. I know that our professor of geodesy beside being a "higher mathematical" theorist (if he were not we would not want him) has set tens of thousands of stakes himself on actual practical work. If he were not an engineer as well as a school teacher we would not want him. You meant, I think, in your editorial to emphasize the opinion that teachers of engineering should be practical engineers. In this I fully agree with you. We certainly want no other kind here. And I also agree with you in your opinion as to the value of approximate mental checks. But on the main thought regarding "higher mathematics" I emphatically disagree, and regret that such opinions should appear editorially in a paper which in general holds such sound views on engineering subjects.

Yours respectfully,

Palmer C. Ricketts,

Rensselaer Polytechnic Institute, Troy, N. Y.,
Oct. 27, 1900.

Sir: I was not particularly interested in the discussion on the setting of slope stakes. The idea of subjecting this work to elaborate mathematical processes when the calculations are performed intuitively seemed ridiculous and a few of the letters amused me. The tape especially seemed to me good, as I have always used one on such work.

I really took an interest in the discussion when the issue of October 18 reached me and I read your timely editorial on the matter of engineering education. I am not a disbeliever in the engineering school. Far from it. But I do not believe the engineering school is dealing honestly with the students. The engineering school should occupy a place somewhat akin to the place it occupied up to a few years ago in England. There the young man was apprenticed to an engineer, and in the winter season, when business was quiet, he attended lectures and classes in the theory of the profession.

It is about time the talk around campfires and some of the dissatisfaction the average engineer feels were published for the benefit of the profession at large. Every engineer has more or less of a kick coming about his college training after a few years of the grind of actual life. Your editorial should continue to be discussed until professors and practitioners are brought closer together. How large a proportion of our engineers have graduated from even the poorest of schools? Make a canvass in all the offices and in the field parties and see. You will be surprised to find how few have gone to any schools where engineering is a major. What is the reason? It is simply that taken year in and year out there is no profession which yields so poor returns for the time spent in preparing for it. There are flush times when engineers are scarce. Then young fellows are promoted to run instruments and there is a step upward all along the line of practical self-taught men. The young, highly educated, hypercritically educated young man finds his education has not increased his chance of good pay and in competition with the untaught instrumentman and draftsman he finds that the latter is preferred on account of his greater experience. When dull times come, the man who is working up from the ranks is better fitted to get along as he will accept any employment, whereas the young educated engineer feels, and naturally so, that a man of his education should not be subjected to such ups and downs. The advantage of the higher education comes in when a man is needed in some special work where the training of the other has not yet fitted him to compete. The educated man tarries no longer in the business than he can and at the earliest opportunity goes into something else, sometimes where his education will be of service and sometimes where it is not. A few, of course, remain in professional work, but they are the fortunate ones. Some go into offices of bridge companies and factories where they remain a life time, but at work where they seldom find real use for their fine education, nor for any more education than they might have picked up if they had entered the drafting room as office boys and worked their way up to the drawing board.

It is not the fault of the school as a school. It is the mistaken idea of the profession held by many professors. There will be a reaction. Twenty-five years ago the whole educational world was startled by a professor of physics who thought it was time to stop lecturing to students on the subject, and having the professors perform all the experiments. He brought out a text book where the laboratory method was used and the students became experimenters. The deductive method was seen to be the best and it became wonderfully popular. So popular, indeed, that the pendulum has commenced the last year or two to swing the other way, as it was found that students were doing entirely too much laboratory work in the way of rediscovering truths and were wasting time. The method now recommended is a mixture of the old way of telling them all and the modern way of letting them do all.

The writer has in mind an institution of higher learning where there is a vacancy in the chair of civil engineering. The first applicant was an eminently practical engineer with more than a dozen years of experience and in various lines of work. But he was rejected because of his lack of teaching experience. The second was a professor of mathematics, but his application has been shelved until a few more come in. His teaching experience is good, but they wish to get an engineering graduate. The third is a last-year graduate of the school in question. He has temporary charge of the classes until the professor is selected. The fourth is a graduate engineer who had one or two years' experience as a teacher and one or two years' experience in some special investigation work for the government, but with no practical experience outside of that. He is in the lead so far and favored. He is a highly trained man in mathematics.

There was another school where civil engineering was not taught. There being quite a number of applications from students for such a course, one was established and the professor of mathematics was put in charge. He knew nothing about it and being bumptious he would not take the advice of any engineers. He took the catalogue of some engineering school and fixed up a catalogue course for himself. He selected the text books himself and with the professor of physics commenced his work. The student is told that he will "read" Searles, Johnson on Surveying, etc. Read! A few of the graduates of that school are moping around the country now. The course in civil engineering is not the strongest course there.

Now it is patent that there should be something different. Students are taken into schools and on account of the competition the courses are becoming too highly specialized. One or two of the oldest schools in the country are going along in the same old sensible way and giving courses in general engineering. The men at the head were too conservative to change their methods when the specialist craze struck the schools and their conservatism stayed with them until the question commenced to attract attention, as it is doing now. They realized that chief engineers were not graduated from school rooms and laboratories, but were graduated in the school of experience. The fresh graduate (and how fresh he is) goes into the drafting office or into the field in a subordinate capacity and gradually works his way up. Their graduates are prepared for that. But nearly all the instructors in those schools are men who have had many years of practical experience and few have gone abroad to study.

The average engineering school is under the control of men who believe every professor should pursue post-graduate study abroad and they ask the same of the engineering professors. These men come back and take young men whom they should be preparing for the sobering experiences of actual life as the engineer finds it and make them laboratory assistants. One course after another is started in some specialty, when every engineer knows it will be almost impossible for a young engineer to select his specialty. In the weary round of "job chasing" the engineer, if he does not get discouraged and take to drink, lands in a place where he may stay for life. He goes in as a subordinate, no matter how good his general training, and works up to the top if he can. Experience as an engineer he must have to secure the position, but experience as a specialist in that particular work, hardly ever.

The writer is acquainted with an engineer who went into the profession as many have done. His common school education completed and there being no high school, he concluded that there was to be no more book learning for him. He cast about for work. Sixteen years old, and a young giant in appearance and strength, he secured a job as axeman for a party of railroad surveyors in vacation time. He had never studied algebra. In fact, he told me once he had never heard of such a study up to that time. Being anxious to learn something about surveying he picked up a second-hand copy of Davies in a town they passed through and devoured it. The few pages in the front on trigonometry and logarithms gave him enough mathematics to understand the work. The other boys in the party laughed at him for studying a book on land surveying, but the transitman encouraged him. When Davies was finished he secured a copy of Shunk and studied all about railroad curves. He rose to be rodman, next leveller, then transitman in the course of two years employment. Then times got hard and he worked as a chainman for awhile for a city engineer. He got off on railroad work again and when the field work was done got into the office because the chief liked him. His bible then was Trautwine. His book of daily devotions was a small old elementary arithmetic. He was fond of working out all kinds of problems and was what the boys called a "regular lightning striker."

He was successful and is successful. He has had charge of important works in irrigation, water supply, sewerage, railroad and engineering work generally. He has designed and built several bridges and one of the things of which he is the proudest is that he never studied algebra. How will we account for it when so many well educated men make failures? Is it not that too many professors chase the elusive x and y through all sorts of strange combinations when they should be chasing the boys around a 700-acre patch over gulleys and through underbrush and over inaccessible paths.

I do not advocate making surveyors of engineering students and losing sight of the fact that the boys are to be engineers. But I do believe that the boys should learn a little less of mathematics, chemistry, physics and astronomy in their regular engineering courses and be filled to the neck with practical instruction on shorter methods of arriving at correct results. With a working knowledge of mathematics, the ability to make a neat and correct drawing, a correct survey, a knowledge of the materials of engineering and skill in the use of practical laboratory methods, any young man of ability should be able to earn a living and make fewer mistakes than when he is too highly educated in a professor's specialty.

My idea of the best engineering instruction is where the student on entrance to the school should be required to pass an entrance examination in the subjects covered in any of our leading academic algebras, in plane and solid geometry and in plane trigonometry. In the school he should not have any more mathematics until he reaches a point in his studies where the knowledge is required, when a very little instruction will fit him to understand the reasoning. He will forget it soon anyhow and never preserve a knowledge of it unless he has a taste that way. He will hardly require any more physics and chemistry than he receives in his High School course, so I would omit it in the engineering school. The same with astronomy. I would give him a good course in physical geography and in the regulation engineering studies such as surveying, descriptive geometry and general mechanical and architectural drawing and design of structures. In a knowledge of materials I would cram him up. In field practice he would be proficient. All this should be done easily in three school years.

But I would not reduce the length of the course. Four years will do him no harm. I would so arrange the course that the students could each spend more time in the fourth year on some special line of engineering work, thus allowing some individual choice. And the time saved from the useless furbelow of science studies would be put in on the German language and a study of history and political economy and sociology. In other words on what are termed the humanities. The engineer has to come in contact with men in all lines of business and yet because he is trained as a specialist he is seldom fitted to discuss in a broad way the important affairs of life. He should be a liberally educated man and in literature and the humanities there is no reason for his being so deficient as we so often find him. The engineer then will take a more prominent position in the world of affairs than he does now when he is simply a "hired man."

While with the training I would give him he might not come up to the standard of an educated man from the standpoint of a special professor, he would come up to the standard of an educated man from the view point of the world at large. Which is the more valuable from the bread and butter point of view?

The specialist should not be excluded. If any young man wishes to put in five years at college (and there will be many to do so) there can be special courses in municipal, sanitary, biological, chemical, mechanical, electrical, mining, metallurgical, mineralogical, geodetical, engineering, etc., and in as many other combinations as the fertile minds of instructors can devise. But what we do want is a more sensible course for the young man doomed to chase the transient job, so that in the periods of lay-off between jobs he can mingle with his fellowmen and be as fairly intelligent as the rest. Let us have fewer men educated in transcendental analysis and cranks on mathematical problems who are yet not well enough informed to discuss the tariff or the money question or to speculate on the future of the poor people around the corner or the Chinamen in far Cathay.

Practical (?).

(We have commented upon the above letters in our editorial columns.—Ed.)

Notes and Queries.

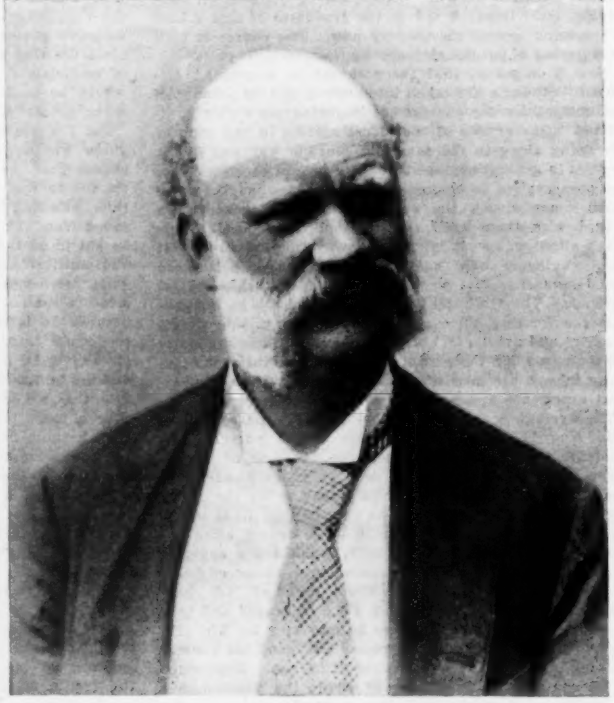
The test of a concrete sidewalk slab noted in a review of a Trade Publication in the supplement of our issue of Oct. 4 (p. 107), was incorrectly reported. The figures given referred to a test of ordinary concrete sidewalk construction. The test of a "Metalloid" slab showed twice the carrying capacity and would not have broken without warning owing to its resilience, which enables it to deflect under load and then recover.

C. E. B., Richmond, Va., asks the following questions: (1) "What are the largest cars used on American railways?" The hopper-bottom cars built by the Pressed Steel Car Co., of 100,000 to 110,000 lbs. capacity, are the

largest in regular service. The largest car in the United States is a special car built by the Pennsylvania R. R. in 1893 for transporting the Krupp 122-ton guns to Chicago. This car weighed, with its load, 445,000 lbs., but it had a wheel base of 80 ft. 3 ins. and was carried on 32 wheels. (2) "What is the weight of the largest locomotive?" The Pittsburg, Bessemer & Lake Erie locomotive, No. 151, built by the Pittsburg Locomotive Works last spring, weighs with its tender 391,400 lbs. It was illustrated and described in our issue of June 26 last, and is the largest locomotive in the world. It can exert a pull (reckoning one-fourth of the weight on its driving wheels) of 56,000 lbs. (3) "What is the highest speed made by a locomotive?" We recall nothing higher than the record of about 110 miles an hour, which is said to have been attained by a special train on the Lake Shore & Michigan Southern a few years ago.

HAMILTON SMITH.

Who that could remember that cheerful, deep, bass voice, the southern twang and form of speech, the genial presence and bright countenance which fairly spoke for honesty of intent and purpose, did not feel a lasting shock of pain at reading in the papers of July 5th that Hamilton Smith had suddenly passed away? Few people there are who have been more widely known, all over the globe, than the subject of this sketch, and few indeed whose loss has been so heartfelt by those who knew him. Born July 5, 1840, near Louisville, Ky., the son of a distinguished lawyer, Hamilton Smith, Sr., originally of Durham, N. H., Hamilton Smith grew up as a boy of six to thirteen in the schools of Durham, at the home of his ancestors. But his academy and scientific school were his father's coal mines at Cannelton, Ky. Here were spent the later years of his youth and his young manhood, in the active work of the mines in all departments, so that when he left Cannelton in 1869 at the age of 29 to go to California, he was already known as a skilful mine manager and a leader of men. On the Pacific coast his first work was as consulting engineer of the Triumfo mine, but his masterwork of that period was in hydraulic gold mining, at the North Bloomfield and other mines in Nevada county. Some of the boldest, and at the same time the most successful, hydraulic works ever built in that land of hydraulic constructions without precedent, the State of California, were built by Hamilton Smith at this period of his life. And that no mere "main strength and stupidity" was his teacher in these structures may be shown among other ways, by reference to his professional papers, dealing with these works, in the "Transactions of the American Society of Civil Engineers (1883, 119; and 1884, 15)." The Rowland prize was awarded Mr. Smith in 1884, for his paper on "Water Power with High Pressures and Wrought-Iron Water Pipe." To this period of his life, and likewise testifying to his philosophic character, belongs also his book, entitled "Hydraulics" (John Wiley & Sons, N. Y., 1886). The writer, who had the privilege of several months' daily companionship with Mr. Smith while certain of the facts for this book were being mined out of the storehouse of nature, can testify to the exceeding conscientious and nigh unprecedented care with which the book was written. "Is this thing true?" seemed to be the question ever present in the mind of its author; and if not capable of positive proof, the verdict was: "we want none of it." It is lamentable to think that despite this unusual care, both he and his friends were cheated and defrauded by a false statement made in an official document, and thus received into the book.



HAMILTON SMITH, M. AM. SOC. C. E.

A prominent actor in the long contest in California between the farmers and the hydraulic miners, and well known upon the whole Pacific coast as an able mining engineer, Mr. Smith left California about 1884, and turned his face towards the two great business capitals, New York and London, for other worlds to conquer.

Already consulted in mining matters (El Callao Mine, in Venezuela), by Messrs. Rothschilds of London, he established himself as a mining engineer in London, in 1886, in partnership with the late Mr. Edmund De Crano. In that year, also, he was married, in London, to Mrs. Charles Congreve, nee Miss Jennings, of New Orleans, La., who survives him.

From thence on, Hamilton Smith's business success may well be described as phenomenal. In 1886 he founded, with the modest capital of $100,000, and in conjunction with Mr. Edmund De Crano, the "Exploration Company, Limited," whose capital was increased in 1889 to one and a-half million dollars, and again in 1896 to six and a-quarter millions. As "imitation is the sincerest form of flattery," Mr. Smith must have been—if capable of it—sincerely flattered by the half-dozen or more London companies who sought to imitate his success under the banner of other "Exploration" companies.

Early in the field in the South African gold mines (he visited them in 1892 and again in 1895), he was one of the first to advocate the deep level quartz mines, and reaped from them the well-earned reward of skill and foresight. At the same time, all the other regions of the earth, especially the unexplored regions, were the stamping ground of his tireless search for mines that it would pay to work. He was thus prominent in the life of the Alaska Treadwell, Alaska United, Alaska Mexican Gold Mining, Anaconda Copper Mining, Fraser & Chalmers, Limited (mining machinery), and many other such first-class companies. But besides all this, many another engineering work occupied the attention of this able engineer, and of the active company which he had founded. The secret and true history of enterprises is not often written, least of all in the newspapers. But were the whole truth told, it is probable that to no one man is the city of London so much indebted for the modern rapid transit facilities it already has, and is yet immediately to receive, as to Hamilton Smith, the good citizen of the two great world's capitals, and promoter of good work, from whatever source it may be procured.

One of his last operations was the securing for himself and friends of a controlling interest in the celebrated Mariposa Grant of California.

He was a member of the American Institute of Mining Engineers, of the American Society of Civil Engineers, and of the Institution of Civil Engineers, of Great Britain.

Since 1896, Mr. Smith had been in partnership with his friend of 29 years' duration, Mr. H. C. Perkins, with offices in New York city, while residing at Washington, D. C., and again in the town of his ancestors, Durham, N. H. It was at the latter place that death overtook him in the enjoyment of his boyhood's pleasures, on the day before his sixtieth birthday, while sailing a boat in the placid waters of Portsmouth's harbored river.

And thus we will think of him drifting out of sight, a man whom it was good to have known, and who had left his impress for good on all who had come in contact with him.

C. H.

New York, Oct. 16, 1900.

(We are indebted to the courtesy of "The Engineering and Mining Journal" for the portrait of Mr. Smith, herewith reproduced.—Ed. Eng. News)

THE SEWERAGE AND PAVING OF HAVANA, CUBA.

Bids for the complete sewerage and paving of the city of Havana, Cuba, will probably be invited by public advertisement in about one month, and owing to the pressure calling for the commencement of the work before the hot season of 1901 sets in, the time to be given to contractors for making up their bids after the advertisement is made will be comparatively very short. The work proposed may cost between $7,000,000 and $8,000,000, and as it will have to be conducted under somewhat peculiar and trying conditions no intelligent bid can be submitted without first visiting the city and having these conditions carefully studied by expert engineers and contractors. It therefore would be well for those proposing to submit bids for this work to set about this preliminary examination at once.

The report of Gen. Wood fully discussing the plans proposed is now in Washington, but has not yet been made public. A fair idea of the general character of this work, however, can be gathered from the following, which consists of facts furnished to this journal by the courtesy of Major Wm. M. Black, Corps of Engineers, U. S. A., the engineer officer in charge:

The sewerage system of Havana will have its initial point in a shaft at the Punta, on the city side of the entrance to the harbor. From this point will start two lines of main intercepting sewers of brick and concrete. The Bay-interceptor will take care of the sewage by gravity for practically all that part of the city lying between the Prado and its prolongation, the harbor, the sea and the Arsenal. For the low area situated near the Arsenal and head of the Bay, a secondary pumping station will be required to lift the sewage to the level of the main interceptor. The second, or Sea-intercepting main sewer will take care of the remaining portion of the city and its suburbs; and there will also be two secondary pumping stations, operated by electricity, in the neighborhood of Vedado.

The sewage will be disposed of temporarily, and during construction, through a stave-pipe leading from the Punta toward the open sea. Final disposal will be accomplished by means of a siphon pipe under the entrance to the harbor, with the main pumping station on the east side of the entrance. There will be a tunnel under the hill between Moro Castle and the Cabana, and then surface excavation to the point of outfall on the coast and an iron pipe leading to deep water. The siphon-crossing of the harbor will present some unusual difficulties, as the excavation on both sides will be in the porous, water-bearing rock underlying this region; and the middle portion will have to be dredged to a practically unknown depth.

The sewers will be made of vitrified clay pipe, up to diameters of about 20 ins., and the larger sewers will be concrete and brick. Throughout the system storm-water drains will discharge into the sea and the bay by the shortest lines. Owing to the unsanitary nature of the soil underlying parts of the areas to be covered by these sewers, unusual precautions will have to be taken

in making excavations. But in this connection it may be said that in the extensive public work conducted by Major Black, no harmful results have followed excavations of this character—where the precautionary rules laid down have been followed. These precautions include the sprinkling of the newly turned-up soil by electrozone, or a chlorine solution; and in bad cases, the immediate dosing of the soil with quicklime and its removal before night.

The street-paving to be done includes the laying of sheet or block asphalt on a concrete foundation on all streets that will permit its use; and acceptable and thoroughly tested makes of vitrified brick pavement on streets of heavier traffic. Sections of test brick pavements have been already laid in Havana, and the report of Gen. Wood will contain the results of the experiments. The plans for the sewerage of Havana were generally drawn up by Mr. D. E. McComb, M. Am. Soc. C. E., and Superintendent of Sewers, of Washington, D. C., under Mr. S. M. Gray, M. Am. Soc. C. E., of Providence, R I., acting as Consulting Engineer; while Mr. McComb devised a combined system of sewerage, Mr. Gray has changed this to a complete separate system.

STANDARD METHODS OF WATER ANALYSIS.*

At its first report of progress the Committee on Standard Methods of Water Analysis presents the results of a careful inquiry into the present status of this general subject. This step was deemed necessary in order to bring to the committee needed information for its guidance in its future plans of action.

About 125 copies of a circular letter, with an accompanying list of questions, were sent to leading workers. The number of detailed replies was fewer than should have been the case. Nevertheless, these replies, with the knowledge which the members of this committee have as to the methods used in the more prominent laboratories, enable us to present a substantially correct resume of existing conditions, as given in the following pages:

COLLECTION OF SAMPLES.

Upon the subject of collection of samples the replies to the question sent to various workers were practically unanimous, and may be summarized as follows:

Bottles for chemical samples should have a capacity of one gallon, should be made of clear white glass in order to facilitate inspection, and should have glass stoppers. They should be washed each time before use with sulphuric acid and potassium bichromate, or with alkaline permanganate, followed by sulphuric acid; they should then be thoroughly rinsed and drained. For shipment, the stoppers and necks of the bottles should be protected with cloth tied over them. They should be packed in cases with separate compartments for each bottle, and lined with indented fiber paper, felt, or some similar substance, or provided with corner spring strips, to prevent breaking. The packing boxes should be covered and provided with suitable fastenings.

Bottles for microscopical samples should have a capacity of at least one quart, and should be of clear white glass, but they need not have glass stoppers. Bottles for bacterial samples should have a capacity of at least 4 ozs. and should have glass stoppers. Before use they should be washed as described above and then sterilized with dry heat for one hour at 160° C., or in an autoclav at 115° C. for 15 minutes. For transportation they should be wrapped in sterilized cloth, or the neck should be covered with tinfoil and the bottles put in a tin box. When bacterial samples must of necessity stand for more than twelve hours before plating, it is preferable to use larger bottles than 4 ozs. The gallon bottle used for the chemical sample may be sterilized and used for the entire analysis. When samples are not plated at the time of collection, they should be kept on ice at not less than 10° C. Portable ice boxes, with separate compartments for the ice and bottles may be sent by express with satisfactory results.

TIME BETWEEN COLLECTION OF SAMPLES AND MAKING ANALYSES.

The allowable time that may elapse between the collection of a sample and the beginning of its analysis cannot be stated definitely, as it depends upon the character of the sample and other conditions, but the following limits are generally safe:

CHEMICAL ANALYSIS.—For fairly pure surface waters, 24 to 48 hours; and for normal ground water, 48 to 72 hours. Polluted water requires analysis within twelve hours.

MICROSCOPICAL EXAMINATION.—For fairly pure waters, 24 hours. If fragile organisms, such as Uroglena, Synura, etc., are present, immediate examination may be necessary.

BACTERIOLOGICAL EXAMINATION.—Immediate plating is always best, but seldom practicable. With fairly pure waters packed in ice plating within twelve hours after collection will not ordinarily introduce errors sufficient to vitiate the results.

PHYSICAL EXAMINATION.

The physical examination includes observations of the temperature, general appearance, color, turbidity and the odor in hot and cold samples.

The temperature should be taken at the time of collection, and expressed, preferably, in Centigrade degrees, to the nearest 0.5 degree. For obtaining temperature of water at various depths the thermophone gives the most accurate results.

The general appearance of the water should be determined by inspection in strong light after standing several hours. Substances remaining in suspension are then classed as "turbidity on standing," and substances settling to the bottom, as "sediment." The terms, none, very slight, slight, distinct, decided, etc., may be used for general work, as described in the reports of the Massachusetts State Board of Health. Where methods are used for expressing the turbidity and suspended matters numerically, as is necessary with sewage and some waters in some lines of work, the description of appearance may be omitted.

At the present time there is no uniformity in the methods of measuring turbidity or suspended matter. The wire method, the disk method, the diaphanometer method, the gravimetric method, and the use of standards of comparison all appear to have their field of usefulness. It is desirable that some system should be adopted for making the results by the various methods comparable, at least for those lines of work of the same general nature. In the absence of the necessary experimental data, your committee is unable to make a definite recommendation at present, although studies now in hand will probably make this possible another year.

For measuring the amount of dissolved coloring matter in waters, the platinum-cobalt scale appears to be very generally used, although the Nessler and natural water standards and other methods are being used in important work. While the platinum standard does not appear to be wholly satisfactory, especially for very dark colored waters, it appears to be generally suitable for ordinary use and serves well as a basis of comparison for all results. Your committee recommends that whenever any other method is used for color measurement, the relation of this method of the platinum standard shall be indicated. In the case of waters which are appreciably turbid, the suspended matters should be removed before determining the color, which relates strictly to soluble matters.

The odor should be observed in both hot and cold samples, and the results recorded in terms expressing quality and intensity, substantially as described in the paper on this subject presented to this Section last year.*

MICROSCOPICAL EXAMINATION.

The modified Sedgwick-Rafter method appears to give general satisfaction. The majority of analysts express the results in "Number of Organisms per Cubic Centimeter," but those who have had the largest experience with the method prefer to express the results in "Number of Standard Units per Cubic Centimeter." Inasmuch as the latter method takes into account the size of the various organisms, and may also be used for the amorphous matter, your committee favors the general adoption of the Standard Unit Method.

CHEMICAL ANALYSIS.

So far as your committee has been able to learn, the chemical methods used for an ordinary sanitary analysis of a water do not vary materially in those laboratories where much of this work is now being done. As a rule the differences which are found appear to be justified by the differences in the nature of the waters and the objects of the work. It appears, however, from general observation, that there is room for improvement in a number of laboratories in which water analyses are made in small numbers and at irregular intervals. The determinations which from general opinion are considered necessary for a satisfactory sanitary analysis of an ordinary water are as follows: Residue on evaporation, total and dissolved, with the loss on ignition in some instances; nitrogen as albuminoid and free ammonia, nitrites and nitrates; oxygen consumed; chlorine; and hardness. The general concensus of opinion regarding these determinations is quite harmonious on the whole, and the best current practice may be outlined in brief terms, as given beyond. (The technical details in question have been omitted.—Ed.)

Within the past few years water analysts have had occasion to study types of water about which very little was known a few years ago, and to assist in a variety of special problems relative to water pollution and various processes for the purification of both water and sewage. Such investigations have naturally resulted in an increase in our knowledge concerning a number of analytical matters, about which there was comparatively little known, in practical terms in this country, a dozen years ago. Among the analytical methods relative to these studies, of a more or less special nature, may be mentioned those for alkalinity, iron, sulphuric acid, carbonic acid, and dissolved oxygen. While the methods for these and other determinations have been carefully worked out with reference to certain conditions and waters of certain types, it is felt by the committee that there are a number of details which can to advantage be left in abeyance until another year. The general trend relative to these so-called special methods is outlined briefly beyond. (Omitted here.—Ed.).

With regard to the limits of accuracy of the several methods under various conditions, the determinations which can be best applied to various problems, the expression of the results of analysis, and the interpretation of their results are all matters upon which the committee has nothing to say until a further expression of experience and views is received from members of the section.

QUANTITATIVE BACTERIAL EXAMINATIONS.

With reference to this subject, there has recently been a marked improvement in the general results obtained in this country. It is true, however, that methods of different workers are still variable to a degree which seems unnecessary, and which is certainly not desirable, when we consider that the value of this class of data relates largely to purposes of comparison.

The amount of agitation which the sample of water should receive before plating, in order to insure mixing and a separation to a reasonable degree of groups of bacteria, is afforded by 25 vigorous shakes of the partially filled sample bottle.

Most workers arrange, so far as practicable, to have not more than about 200 colonies on the ordinary plate, such as Petri dishes having a diameter of about 10 cm. For those waters in which such numbers of bacteria are contained in small fractions of one cubic centimeter, it is the general practice to dilute them with sterilized water, rather than to use pipettes delivering small fractions of one cubic centimeter.

With regard to standard conditions of cultivation, the best available evidence shows that it should take place in the dark and in an atmosphere in which moisture and oxygen are always present. Petri dishes sometimes fit too tightly to give satisfactory results, and attention is necessary to these particulars. Cultivation should be at a practically constant temperature of 20° C., and it is gratifying to note that in many laboratories this standard has been adopted, notwithstanding the care and expense which it sometimes involves.

The period of cultivation still varies considerably in the different laboratories. There is a well-defined movement, however, towards shorter periods in order to secure greater practical value for the data. These practical advantages outweigh the smaller numbers obtained from a shorter period, especially as all results have only a relative and not an absolute value. In Germany 48 hours is the standard period of cultivation, and daily results have been obtained on this basis from each of 26 water purfication plants in operation in that country. There seems to be no good reason why the bacterial results to be obtained from the various water purification plants now in operation and about to be built in this country should not be comparable with those obtained abroad. This is especially true in view of the growing appreciation of the fact that the residual numbers of bacteria in a filtered water should receive attention as well as the percentage of bacterial removal. Taking everything into consideration, it would appear to your committee to be advisable to adopt 48 hours as a standard period of cultivation under the conditions noted above, although before making a final recommendation there is requested a further expression of opinion on the part of the members of the section.

Relative to recording the numbers of bacteria per cubic contimeter, there are many workers whose custom is very loose and unscientific. Your committee disapproves of customs which indicate a fictitious accuracy in current methods, by the inexcusable use of significant figures in the units place where the numbers are very high.

DIFFERENTIATION AND CLASSIFICATION OF SPECIES OF BACTERIA.

This branch of bacteriology is of much importance in connection with water analysis, because reliable and readily available methods for the detection of water-borne disease germs cannot be established until this general subject has been placed upon a more scientific and substantial basis. It is true, of course, that progress for a time along this line must be largely a matter of pure science, and that interest in these developments is shared not only among water analysts, but all workers in applied bacteriology.

Your committee has made every reasonable effort to secure a consensus of opinion as to how this subject now stands, with reference to the soundness or weakness of the various current methods and procedures. While the views of a number of prominent workers, especially those not directly connected with water analysis, have not yet come to hand, it is believed that the general status of affairs may be correctly outlined as follows:

It is now universally recognized that the first requisite towards successful work in this field is the use of culture media of uniform standard composition. With this view to the accomplishment of this end, the methods of prepara-

*Abstract of a report to the Section of Bacteriology and Chemistry, American Public Health Association, of the Committee on Standard Methods of Water Analysis. Mr. Geo. W. Fuller, Assoc. M. Am. Soc. C. E., Chairman, 220 Broadway, New York city. Presented at the Indianapolis meeting, Oct. 22, 1900.

*Trans. Am. Public Health Assoc., 1899.

tion of media recommended by the Bacteriological Committee in their Report of 1897 are in general use. Taken as a whole, they seem to have given, and to still give, general satisfaction. It is true, however, that in several laboratories these recommendations are departed from with regard to manipulations which apparently affect but little the question of uniformity.

In brief terms it may be said that, with regard to the general subject of species differentiation, a material step in advance has been taken in consequence of the Report of the Bacteriological Committee of 1897. As a result of the added knowledge coming to various workers through the general use of the 1897 report as a guide, the time has arrived when that report can and should be revised. Concerning the new evidence which has been obtained since that report was prepared, it has not yet reached your committee in a form adequate to allow changes to be recommended at this time. In fact, there are many indications which go to show that the amount of directly comparable evidence from the various laboratories is much less than is generally realized, owing to the wide variety in the nature of the species work now going on in this country.

In the opinion of your committee the real issue for discussion to-day on this topic is not the question of detailed points of improvement, but rather the best general procedure by which species work can be elevated to a higher plane of excellence. This matter has received considerable thought from the committee, and it would appear that as a first requisite it will be necessary to secure the co-operation of the workers in all branches of bacteriology. It would also appear to be necessary to secure comparable data upon corresponding cultures of the same species from a considerable number of experienced workers. Further, it would be very desirable if data from the same species could be obtained at the same laboratory with culture media prepared by a number of other investigators.

FERMENTATION TESTS AND THE DETECTION OF B. COLI COMMUNIS AND OTHER SPECIFIC FORMS.

While these matters come within the scope of general species methods for bacteria, it is considered that they are entitled to separate consideration. This is due to the fact that this subject is studied by many water analysts who do not attempt general species determinations, and to the further fact that upon these topics opinion is more crystallized than upon the general subject of species methods.

With regard to the isolation of B. coli communis there are evidently quite a number of procedures which are used with success. Those procedures differ somewhat on account of the wide range in natural conditions under which tests are made for this form in various waters. Where B. coli communis forms a small percentage of the total bacteria, the custom appears to have come into general use of employing a preliminary incubation to eliminate ordinary water bacteria. It is thought that it will not be a laborious task during the coming year to draft a graded series of acceptable methods to cover the wide range of conditions met with in practice.

It is gratifying to note a general uniformity in the characteristics considered essential to the identification of B. coli communis, as follows:

(1) Fermentation of dextrose with the production of carbonic acid equal aproximately to 33% of the total gas formed.

(2) Coagulation of milk.

(3) Non-liquefaction of gelatine, with growth at the surface and in the form of beads along the line of inoculation in a gelatine tube culture.

(4) Formation of indol.

(5) Conformity to the main morphological characteristics of this type as published.

Very few, if any, experienced bacteriologists engaged in public health work make a practice of attempting to isolate the typhoid bacillus or any specific forms other than B. coli communis. For obvious reasons it is inadvisable at this time to give this phase of water analysis any detailed consideration.

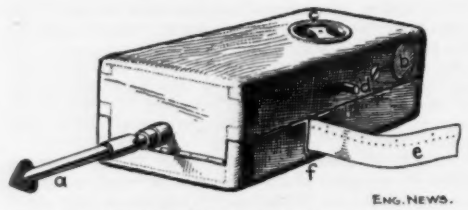
A NOVEL SPEED RECORDER.

The instrument illustrated herewith is designed to make a record of the revolutions of a shaft or other rotating body synchronously with a record of the time in seconds. The record is made in the form of punch marks upon a paper tape.

The general appearance of the device can be seen in Fig. 1. The spear-point spindle (a) at the end is similar in purpose and design to those usually provided on revolution counters. When not in use it can be placed in a receptacle (b) in the side of the case. The key (c) is for winding the contained watch movement, and the button (d) throws the recording mechanism into action. The disposition of the paper tape (e) and the recording mechanism, is shown diagrammatically in Fig. 2.

For our present purpose it is not necessary to enter into a detailed account of the construction and mode of operation of the latter, but the manner of using the device may be described as follows:

The spear-point (a) is pushed against the end of the shaft with sufficient force to prevent slipping. When the operator wishes to commence taking a record he presses the button (d) and the perforated tape issues from the opening (f). The



ENG. NEWS.

Fig. 1.—A Novel Speed Recorder, Invented by Alva T. Hill, 432 Fourth Ave., Detroit, Mich.

action is the same whether the shaft is rotating to the right or left. The power for moving and punching the paper is furnished entirely by the shaft, and not by the watch mechanism, which is only required to operate periodically a detent.

The appearance of the tape is shown in Fig. 3. The long row of single dots represent the revolutions, the double dots the seconds, and a single extra dot is punched for every fifth revolution for convenience in counting. Also, every twentieth

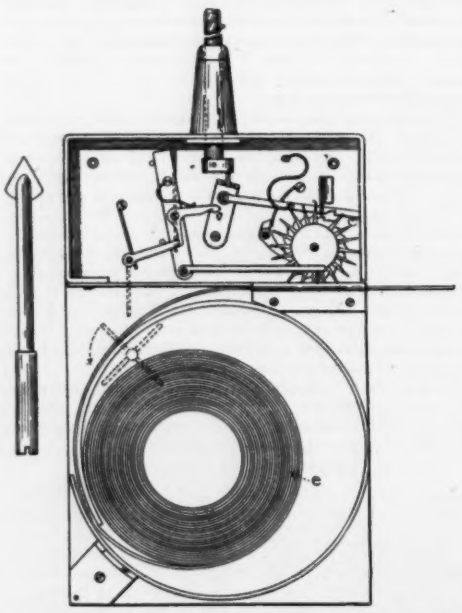


Fig. 2.—Diagram Showing Arrangement of Tape and Recording Mechanism of Speed Recorder.

dot in the long row is omitted for the same purpose.

The accuracy of this instrument should be very great as compared with that obtained by using a stop-watch and an ordinary revolution counter. The only possible source of error is in the time-keeping of the watch movement, which is less than $\frac{1}{1,440}$. All variations due to "personal equation" are eliminated by this instrument. In addition the tape will show any variations in speed

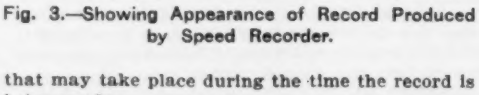


Fig. 3.—Showing Appearance of Record Produced by Speed Recorder.

that may take place during the time the record is being made.

For the latter purpose, especially when the rate of speed is below 100 revs. per min., an instrument is being constructed which will record $\frac{1}{10}$ revolutions when it is desired. Two spindles will be provided, one counting whole revolutions for ordinary purposes, and one recording tenths for use with slow-speed engines or other slowly moving machinery.

This device is the invention of Mr. Alva T. Hill, 432 Fourth Ave., Detroit, Mich., who is placing it upon the market. We are indebted to him for the material from which the above description has been prepared.

BOOK REVIEWS.

UNIVERSAL DIRECTORY OF RAILWAY OFFICIALS, 1900.—Compiled from official sources by S. Richardson Blundstone, Editor of "The Railway Engineer." London. The Directory Publishing Co., Ltd., Brooklyn, E. A. Simmons. Cloth; 6 × 8½ ins.; pp. 563. $2.50.

This volume contains a complete directory of the railway officials of the world, statistics of the various railways, a directory of manufacturers of railway supplies, and a directory of hotels. It is thoroughly indexed.

COMPOUND ENGINES.—A series of lectures by F. H. Low; reprinted from the columns of "Power." New York: The Power Publishing Co. Flexible cloth; 6½ × 9 ins.; pp. 52; 37 illustrations. 50 cts.

This pamphlet is intended particularly for engine builders; but it will be found very useful by the student or engineer who is unfamiliar with the subject. Without going very deeply into thermodynamics or other abstruse matters, the author discusses quite fully the subjects of most desirable ratio of expansion, receiver volume, "drop," ratio of cylinders, etc.

LAND AREA TABLES.—Compiled by Wm. Codd. Folding chart, canvas backed; 15 × 16 ins. London, E. & F. N. Spon; New York, Spon & Chamberlain. $1.40.

This chart contains nine convenient tables for use in calculating the area of land from maps or plans by the process of measuring the area of map surface with a planimeter and computing the actual area from the result. The areas are given in acres, roods, perches and yards, and there are tables of "Old Scotch" measure, "Old Irish" measure, and "Channel Islands or Old Norman measure," all more curious than useful to an American engineer. The price asked for the chart appears out of proportion to its cost of production or practical value.

DIE STEUERUNGEN DER DAMPFMASCHINEN.—By Carl Leist, Professor in the Royal Technical High Schools at Berlin. Berlin: Julius Springer. Cloth; 6½ × 9 ins.; pp. 770; 391 illustrations. $6.00.

This is an exhaustive treatise on steam-engine valves and valve gears. Proceeding from an analysis of the indicator card, the author takes up the various valves and valve motions in use in America and Europe. Particular attention is given to piston and poppet valves and to the cam and other gears for controlling the latter. The illustrations are excellent; they are drawn to scale and show the various devices as applied by the individual engine builders, the names of the latter being given in each case. This is the best book on the subject that we have ever seen.

EXPORTS OF IRON AND STEEL, which suffered a marked reduction through the high prices which prevailed during 1899, are again breaking all records by their volume. The total shipments of pig iron from Alabama and Tennessee in September were 110,400 tons, of which 55,020 tons were exported. In September of 1899 the exports of pig iron from this district were only 13,284 tons. Besides the pig iron this district also exported 1,835 tons of cast-iron pipe and 769 tons of steel. The last-named article was from the new steel works at Ensley, and its shipments of its product to European markets is an interesting commentary upon its position as a low-cost producer of steel. It is stated that the Southern iron shippers secure very favorable freight rates at this season of the year, as iron is in demand as ballast by vessels carrying cotton from the southern ports.

PROGRESS IN CUBA is reported upon by Gen. Leonard Wood. Since the American occupation every town of consequence has been supplied with a well-equipped hospital and public buildings everywhere have undergone extensive repairs. The sanitary condition of towns has been especially improved, and for the first time in their history the two eastern provinces have passed a summer without a single case of yellow fever; and there has been a great improvement in health throughout the whole island. Plans are now ready for the paving and sewering of Havana and its suburbs, and the work may soon be let. Santiago is now largely paved with modern pavement, and similar municipal progress is in evidence in other towns. The traditional Spanish beggar has almost entirely disappeared.

AMERICAN TRADE WITH CHINA increases more rapidly than that of any of the European countries, says the U. S. Bureau of Statistics. The imports into China from the United States, for 1899, were valued at 22,288,745 taels (72 cts. to one tael), as compared with 17,163,312 taels in 1898, 12,440,302 taels in 1897, 11,929,853 taels in 1896, and 5,093,182 taels in 1895. In these five years the imports have quadrupled. In the same period the imports from England increased from 33,960,000 taels in 1895, to 40,161,115 in 1899; and imports from Europe—

Russia excepted—increased from 7,552,000 taels to 10,172,388 taels. The percentage of increase is thus 18% for England, 35% for Europe and 337% for the United States.

THE FOUREAU-LAMY SAHARA EXPLORING expedition has returned from West Africa to Bordeaux, after making a trip across the Sahara from Algeria to the French Congo. The expedition was the best-equipped and largest that ever entered the Sahara, and is said to have gathered up much valuable scientific information. It started in the latter part of 1898, with a total of 200 men and 1,000 camels.

THE TRANS-SIBERIAN RAILWAY TRAINS, now starting each week from Moscow for Irkoutsk and consuming nine days on the trip, are made up as follows, says the "Revue Generale des Chemins de Fer:" Each train is composed of five long cars mounted on trucks and communicating with each other. Of these one is first-class and two are second-class, one is a dining and saloon car and one is for baggage, etc. These cars are heavily carpeted and the top and sides are lined with cardboard and thick stuff, to provide against too sudden changes of temperature in a country where the thermometer sometimes falls to 10° F. below zero. These cars are heated by steam and hot-water, and they are well ventilated. In summer refrigerating apparatus is installed, to cool the air. Fixed and portable electric lamps light the interior of the cars. In the baggage car are installed the kitchen, electric machines, reservoir for water, ice-chest, the berths for the staff of 15 men—or 17 in winter—the linen and food storerooms, tools, etc. There is a library in the saloon and dining-car, a bath fitted with gymnastic apparatus, and a barber-shop, and also toilet-rooms and a dark-room for photography. This train will carry 66 passengers, with 18 first-class. There are also two special compartments fitted with large baths.

ANNUAL MEETING, AMERICAN SECTION, INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

The third annual convention of the American Section of the International Association for Testing Materials was held at the house of the American Society of Mechanical Engineers in New York city on Oct. 25, 26 and 27, with about 20 members in attendance. Owing to the character and importance of the work brought before the convention this small attendance was somewhat disappointing. It was also a matter of some remark that, with one exception, none of the New York members and no New York engineer or manufacturer did more than to attend formally for a few minutes any of the sessions. Despite the lack of attendance, however, perhaps in a measure because of the few members present, the discussion was animated and generally well directed. To understand clearly the purpose and character of this discussion a few explanatory remarks are desirable.

The International Association for Testing Materials performs its work largely by means of committees. Generally each of these committees is composed of one or more members from each of the principal countries represented in the membership of the association. Committee No. 1, which is constituted exactly as described, has for its work the preparation of standard international specifications for iron and steel for various purposes. The plan of work of this committee as suggested by the American members is substantially as follows: The members from each country are presumed to prepare a series of specifications representative of the practice of the country from which they come; these specifications from the various countries are to be considered by the International Committee as a whole and from them standard international specifications are to be drafted, and, finally, these proposed specifications are to be discussed and voted upon by the whole membership of the International Association in all countries.

The American members of Committee No. 1, aggregating 34 members, with five votes in the International Committee deliberations, has as the result of some 18 months' work made the preliminary draft of a series of specifications for iron and steel for various purposes. The chief purpose of the third annual convention of the American Section of the International Association just held was to discuss these tentative specifications. With the aid of the suggestions and criticisms brought out in this discussion the American committee members are to prepare a second draft of the various specifications to be submitted to the fourth annual convention of the Section for discussion, amendment and adoption as the definitive specifications to be presented to the International Committee by its American members. To summarize briefly, the principal work of the Third Annual Convention of the American Section of the International Association for Testing Materials was to discuss the draft of specifications presented by its Committee No. 1. In Engineering News of May 17, 1900, there will be found a brief discussion of the committee's work, together with its proposed specification for Structural Steel for Bridges and Ships. With this preliminary explanation the narrative of the convention work may be resumed.

THURSDAY'S SESSIONS.

Two sessions of the convention were held on Oct. 25. At the opening or afternoon session the proceedings were confined entirely to routine business. The Chairman, Mr. Mansfield Merriman, M. Am. Soc. C. E., delivered a brief address reviewing the standing and work of the American Section. The address called attention to the fact that in many respects the organization and working methods of the parent association were far from satisfactory to the American Section. This was particularly true regarding the publications. Another feature of the business methods which was unsatisfactory was the practice of making no accounting of the money of the association. The Chairman was disposed to think that the only remedy was the complete reorganization of the association. The plan of reorganization recommended was to let the members of each country form a section with its own officers, by-laws, etc., and let these sections exchange publications and general records. To allow for the periodical conference of the different sections Congresses could be held at intervals of two years.

The Chairman's address was followed by the report of the Secretary, Mr. Richard L. Humphrey, which showed the membership of the American Section to be 160. The Treasurer's report showed the receipts of the section to have been $705 for the publication fund and $451.23 for the general fund; the expenditures being $771.96 for the publication fund and $336.39 for the general fund. The report of the Publication Committee showed that 20 Bulletins had been published and widely distributed.

The reading of the reports of officers was followed by the election of new officers for the ensuing year. The election resulted in the choice of the following officers: Chairman, Prof. Henry M. Howe; Vice-Chairman, Dr. C. B. Dudley; Secretary, Prof. J. M. Porter; Treasurer, Mr. Robert W. Lesley, and American Member International Council, Prof. Henry M. Howe.

The evening session of Oct. 25 was devoted to the discussion of the specifications presented by Committee No. 1. The first specification was that on

STRUCTURAL STEEL FOR BUILDINGS.

The discussion was opened by Mr. C. B. Dudley, who asked why the specification stipulated the process by which the steel should be manufactured. After some deliberation the Pennsylvania R. R. Co.'s motive power department had decided not to do this. He considered that the method of manufacture was the business of the manufacturer and should not be interfered with, providing he turned out the quality and composition of steel required. He felt in something of the same mind as Prof. Kirkaldy who once said that the manufacturer might use sawdust and glue providing he produced from them the quality and composition of material desired. Mr. A. L. Colby (Bethlehem Steel Co.), referring to Dr. Dudley's remarks stated that when he had brought this proposed specification before the International Congress of Methods of Testing Materials of Construction at the Paris Exposition a common comment had been that the manufacturer's hands should not be tied by stipulating the method of manufacture to be adopted. It was also generally considered that the requirements of the specification were too many and too severe and that they could not be enforced in Europe. Mr. Stafford (Illinois Steel Co.) thought the naming of the process of manufacture was unnecessary. Bessemer steel could be made as uniform as open hearth by using pig iron having the same percentage of phosphorous. In answer to a question the speaker stated that Bessemer steel could not be made down to 0.04% phosphorous.

Mr. H. H. Campbell (Pennsylvania Steel Co.) considered that the method of manufacture was not such a minor matter as had been stated. Metallurgists he thought were in substantial agreement that a more regular product was secured by the open hearth process. He believed that no specification would be accepted by American engineers which failed to stipulate the process of manufacture. A member supported Mr. Campbell by remarking that the engineer was under the obligation to his client to employ the material generally conceded to be the best and people were generally of the opinion that open hearth steel was the best. While it might be possible with sufficient care to make Bessemer steel as uniform as open hearth steel it was unwise to trust entirely to the manufacturer to exercise this great care. In conclusion several members of the committee called attention to the fact that it was the almost universal practice to specify the method of manufacture in this country and this specification as a representative one could not well ignore this general practice.

The next question to come up was the value of specifying the elastic limit. Mr. T. L. Condron (Pittsburg Testing Laboratory) was disposed to question the value of the ordinary determination of the elastic limit as a commercial test. Mr. C. B. Dudley (Pennsylvania R. R.), stated that he never used elastic limit in specifications. He did not ignore the value of this property, but to determine it by any commercially practicable test was a very difficult task. Mr. H. H. Campbell (Pennsylvania Steel Co.) considered that the whole question was settled by the fact that the designing engineer would not listen to the abolition of the determination of elastic limit. At this point the discussion was postponed until the next morning's session.

The morning's discussion was started by a vote approving the requirements respecting the method of manufacture as they were printed. Mr. Stafford (Ill. Steel Co.) urged that the figures for yield point, which the specification placed at one-half the upper limit of tensile strength, should be changed to "be not less than 50% of the ultimate strength secured by test." This change was adopted by vote. Mr. Paul Kreutzpointner (P. R. R.) moved that in making bending tests it should be stipulated that the edges of the test specimen should be planed. This modification was also adopted by vote.

FRIDAY'S SESSIONS.

At the three sessions on Friday, the discussion was resumed on the specifications suggested by Committee No. 1. The various specifications were taken up section by section; a motion was made to approve each section as it stood, and after discussion this motion in its original form or as amended was put to vote and either carried or voted down. By this mode of procedure some definite results were arrived at in place of the vague action of the preceding session.

SPECIFICATION FOR STEEL RAILS.

Referring to the first section, which stipulated that "steel may be made by the Bessemer or open-hearth process," Mr. C. B. Dudley (P. R. R.) made a motion that the method of manufacture be not made a part of the specification. Mr. H. H. Campbell (Pa. Steel Co.) had found that in filling foreign orders for rails that it was desirable to have many clauses, which seemed to be somewhat unnecessary, retained as a matter of business policy, and he therefore approved the clause as it stood. Mr. Dudley took issue with the advocacy of long specifications, considering that in view of the diverse interests to be satisfied the specification should be as short and simple as it was possible to make it. He regarded the specification under discussion as open to the charge of being a manufacturers' specification. Mr. A. L. Colby (Bethlehem Steel Co.) thought that the last charge was unwarranted; during his visit to Europe this summer, indeed, a common criticism of foreign engineers had been that the requirements were too hard on the manufacturer. He further stated that one reason for adopting the clause criticised was to make the specification uniform in plan with the others of the series. Prof. H. M. Howe summed up the discussion by stating that if the clause, although perhaps unnecessary, served any purpose whatever, and was not injurious it would seem advisable to retain it. Upon vote, Mr. Dudley's motion to strike out the clause was lost.

The second point of the specification over which discussion arose was the one stating that, "Sufficient material shall be discarded from the top of the ingot to insure sound rails." Mr. C. B. Dudley (P. R. R.) thought it important to state definitely whether it was the intent of the clause to require enough discard to do away with piping only or with both piping and segregation. He regarded segregation as one of the greatest dangers against which purchasers of rails had to defend themselves, and thought that if any means were possible by which the specification could be made to shut out its possibility, that this means should be adopted. Mr. H. H. Campbell (Pa. Steel Co.) stated that to insure against segregation by the discard would make it necessary to throw away at least half of each ingot. Mr. Stafford (Ill. Steel Co.) thought that much might be done toward sifting out segregated rails by always making a drop test on the rail which came from the top of the ingot. This he stated was the universal practice of the Illinois Steel Co. Mr. C. L. Huston (Lukens Iron & Steel Co.) made a motion that the clause quoted should be amended by making it read "to insure sound rails and freedom from injurious segregation." This motion was put to vote and carried.

The specification calls for a higher percentage of carbon in rails of large section than in rails of small section, the figures being as follows:

Weight of rail.	Per cent. of carbon.	Weight of rail.	Per cent. of carbon.
50 to 59 lbs.	0.35 to 0.45	80 to 89 lbs.	0.43 to 0.53
60 " 69 "	0.38 " 0.48	90 " 100 "	0.45 " 0.55
90 " 79 "	0.4 " 0.5		

Mr. C. B. Dudley (P. R. R.) asked the reason for this increase. It had been something of an opinion with him that the carbon should be decreased as the section increased. With large sections of rail the tendency was to finish the rolling at a high temperature, and this was an objectional matter. By decreasing instead of increasing the carbon, it will be necessary to finish the rail at a low temperature. Mr. P. E. Carhart (Ill. Steel. Co.) called attention to some practical experiments made by the C., B. & Q. R. R., which seemed to indicate that the benefit of cold rolling was not so certain as was commonly asserted. Some years ago this railway had been given "carte blanch" by the Illinois Steel Co., to roll a large number of rails for experimental use at different finishing temperatures. These rails had been rolled very cold in some cases and very hot in other cases, and then put into the track side by side. An officer of the railway had recently been reported as saying that so far he had been unable to discover any difference in the service of the rails finished hot and those finished colder. Mr. H. H. Campbell (Pa. Steel Co.) stated that it was a commercial impossibility to finish rails at the temperature of recalescence. After some further remarks it was voted to let the clause stand as printed.

The next point over which any discussion arose was the

clause relating to test pieces, and methods of testing which reads as follows:

The drop-test machine shall have a tup of 2,000 lbs. weight, the striking face of which shall have a radius of not more than 5 ins., and the test rail shall be placed head upwards on solid supports 3 ft. apart. The anvil block shall weigh at least 20,000 lbs. and the supports shall be a part of or firmly secured to the anvil.

Mr. C. B. Dudley (P. R. R.) in criticism of this clause called attention to the fact that far different results were obtained in drop-testing machines due to the different proportions of the shock absorbed by the anvil block. This would differ in hard and soft ground, whether the ground was frozen or not, with the weight of the anvil block, etc. To provide against this trouble his company were using an anvil block mounted on springs, which, while it gave a yielding anvil, placed all tests on the same basis wherever the machine was located and whatever the character of the foundation soil might be. He also considered that the measurement of the deflection of the rail was indicative of the ductility of the metal in the rail, and thought that possibly it might be well to specify a limit of deflection under say the first blow. The railways wanted a rail which was not only stiff, but one which would wear well and for the last purpose the ductility of the metal was important. Prof. Mansfield Merriman stated that the important thing was to secure a rail which would stand work, and its ability to stand work was due to two qualities—first, the ultimate strength of the metal, and, second, its ductility. Mr. H. H. Campbell (Pa. Steel Co.) considered that an accurate test of ductility was so difficult to secure as to make it impracticable as a commercial test. Assuming that the deflection under the drop test gave a measure of ductility, then the ultimate ductility was measured by the amount of deflection under the breaking blow, and the deflection could not easily be measured at the moment of breaking. Mr. P. E. Carhart (Ill. Steel Co.) called attention to the fact that only two rail specifications now in force—those of the Michigan Central and of the New York Central railways, call for a test for ductility. He considered that if the deflection under the drop test was to be limited, then it was unjust to specify the carbon limits in the chemical composition. Mr. A. L. Colby (Beth. Steel Co.) thought that the objects of any rail specification were simply to secure, (1) a safe rail; (2) a hard rail, and, (3) uniformity. These results might be obtained either by requiring a deflection limit, or by requiring a carbon limit; but if one is limited the other should not be. It was easier to secure the results named by regulating the carbon than by a deflection test, and he, therefore, considered it the preferable way. Prof. H. M. Howe thought that the deflection under a single blow of the hammer was a very rough and insecure measure of ductility. Upon the motion of Mr. C. B. Dudley it was voted that it was desirable to embody a deflection requirement in the specification.

The discussion next turned to the value of the ladle analysis required by the specification. Mr. C. B. Dudley (P. R. R.) considered that, while the ladle analysis was a desirable thing for the information of the steel maker in carrying on his work, it placed all the responsibility for segregation on the consumer. He would advocate that the analysis be made from borings from the finished product. Prof. H. M. Howe remarked that occasional segregation was always covered up by the ladle analysis. Mr. C. L. Huston (Lukens Iron & Steel Co.) stated that the finished product always disclosed more impurities than the ladle analysis indicated. Mr. P. E. Carhart (Ill. Steel Co.) thought that if with each heat a drop test was made on the top rail of the ingot all reasonable precautions against segregation had been taken. It was finally voted that the clause regarding the ladle analysis should remain as printed.

SPECIFICATIONS FOR SPLICE BARS.

The discussion of this specification was brief and it was finally voted that it should stand as printed. Dr. C. B. Dudley (P. R. R.) called attention to the fact that splice bars were breaking badly on all railways. His observation had shown that in nearly all cases the break began at the top of the splice bar just under the head of the rail and progressed downward. He had attributed this to the strain brought onto the bar by the lifting of the rail at the joint as the load approached the joint. He had had this strain calculated and if the assumptions in this calculation were correct there was a fiber stress at the top of the bar of 33,000 lbs. per sq. in. He had found that splice bars containing more than 18% carbon cut the underside of the rail head.

This discussion closed the work of the morning session with the exception of some routine business, the most important of which was the drafting of a formal notification to be sent to President Tetmajer, of the International Association, announcing the election of Prof. H. M. Howe as the American member of the international council.

STRUCTURAL STEEL FOR BRIDGES AND SHIPS.

The discussion was started by an inquiry made by Mr. R. S. Buck. M. Am. Soc. C. E., as to the relative reliability of acid and basic open hearth steel for important bridges like those proposed to cross the East River at New York city. In reply Mr. Wm. R. Webster stated that satisfactory steel of from 70,000 lbs. to 80,000 lbs. tensile strength could in his opinion be made by either the acid or basic process. This opinion was agreed in by Mr. Stafford (Ill. Steel Co.), with the qualification that much greater care must be exercised in handling the steel after it left the maker. Mr. H. H. Campbell (Pa. Steel Co.) came out squarely with the opinion that acid steel was more uniform in quality and a better material for high class work than basic steel. From the point of view of cost of manufacture 0.04% phosphorous basic and 0.08% phosphorous acid steel were on the same basis. Mr. Stafford (Ill. Steel Co.) would consider a 0.04% phosphorous basic steel a more reliable material than a 0.08% phosphorous acid steel. In structures of the importance of the East River bridges he would advocate that a great many bending tests be made whatever the process of steel manufacture adopted. Mr. John McLeod (Carnegie Steel Co.) stated that for the quality of steel required he should not hesitate to use either basic or acid steel. He did think, however, that steel of 72,000 to 80,000 lbs. tensile strength should be used only when it was impossible to use any other, because it required the most careful manufacture and inspection to secure the quality. Mr. C. L. Huston (Lukens Iron & Steel Co.) stated that for marine boiler plates it had been his experience that basic steel was fully as reliable and satisfactory as acid steel. Dr. C. B. Dudley (P. R. R.), speaking of high carbon steel, considered its requirement to be in the line of progress, but as the percentage of carbon went up the manufacturer had got to be more closely watched. For any purpose where alternate stresses prevailed he believed high carbon steel to be better than low carbon steel.

With this preliminary discussion the specification was voted on section by section. In the section relating to yield point the same modification, that the yield point should not be less than 50% of the tensile strength, as was adopted in the specification for steel for buildings, was adopted here. It was also voted that the clause relating to bending test specimens should be modified to provide that these specimens should have their edges planed or milled. It was also voted that a clause be added providing that when the gaged thickness did not vary more than 1-100-in. from the specified thickness it should be accepted as up to specification.

BOILER PLATE AND RIVET STEEL.

The principal discussion of this specification revolved around the point that no specification for carbon existed. Dr. C. B. Dudley (P. R. R.) considered that the consumer should have the right to specify the carbon limits and asked why it was omitted in this specification. Mr. H. H. Campbell (Pa. Steel Co.) stated that the reason was that in case the carbon was specified with the other requirements the physical requirements and the chemical requirements would be partially exclusive. The clause was adopted by vote as printed. By similar votes the modifications regarding yield point and planed bending test pieces which were adopted in the specifications for building and for bridge steel were adopted here also.

STEEL AXLES.

This specification called for a standard test specimen ½-in. in diameter and 2 ins. gaged length and this was practically the only point discussed. Mr. Paul Kreutzpointner (P. R. R.) objected vigorously against relying upon so small a test piece for determining the strength of axles. He considered that a fair representation of the material could not be obtained by a test piece of such small section. In proof of this he displayed several sections of segregated axles and pointed out that according as the test piece was located it might consist wholly of metal from the segregated portion or wholly of metal from the sound portion and in either case would give entirely misleading results. He considered that this danger was avoided by taking a test piece of not less than 1 sq. in. cross section and 8 ins. long. Dr. C. B. Dudley (P. R. R.) spoke at length on the same matter. After some further discussion it was voted to refer the whole specification back to the committee for reconsideration.

The following specifications for "Steel Tires" and for "Steel Castings" were voted adopted without change, after a brief discussion. At the request of the committee the specification for "Wrought Iron" was referred back to it for reconsideration, it not being satisfactory even to the committee as it stood.

STEEL FORGINGS.

The only point of this specification which called out any particular discussion was that stipulating a ½ × 2-in. test piece. This small test piece was objected to by Mr. Paul Kreutzpointner for the same reasons that he objected to the same size test piece in the steel axle specification. To settle the matter it was voted that the whole matter of the size of test piece for steel axles and steel forgings should be referred back to the committee. In this connection Mr. A. L. Colby (Beth. Steel Co.) stated that he would have compiled the lengthy series of tests made by the Bethlehem Steel Co., to determine the comparative advantages and value of 2-in. and 8-in. test pieces for steel forgings.

SATURDAY'S SESSION.

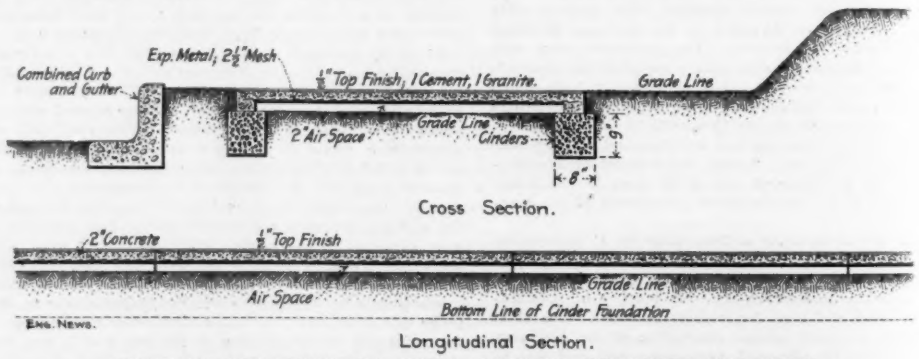
The greater part of the session on Oct. 27 was taken up with routine business, which calls for no particular mention.

CONCRETE AND STEEL SIDEWALK.

In the construction of the ordinary style of concrete sidewalk, built in place, there is frequent complaint from the use of improper material, improper mixtures, and defective work, while repairs necessitate the tearing up and reconstruction of entire sections of the sidewalk. We illustrate herewith a form of sidewalk construction in which concrete slabs are used, made at a factory so that they can be inspected and tested as desired. Embedded in each slab, near its lower surface, is a sheet of expanded metal which prevents cracking or fracture, and strengthens the slab to such an extent as to permit of the use of a cheaper grade of concrete than the 3 to 1 mixture very generally used for such purposes. The slabs, as shown by the cross section, have 2-in. flanges at the sides, these resting upon beds of cinders or gravel laid in trenches, and leaving an air space of 2 ins. under the pavement. The ordinary mixture is 1 part of Portland cement to 5 parts of limestone screenings containing enough fine material to render sand unnecessary. This is 2 ins. thick, and is covered by a ½-in. finish of Portland cement and crushed granite, 1 to 1. Another construction has 1 part Portland cement, 2 parts sand, and 5 parts cinders, with a ½-in. top finish of 1 part Portland cement to 2 parts of sifted granite or other fine stone. Repairs are easily made and slabs may be removed to allow of excavations across the sidewalk.

In regard to the cost, we are informed that it may be 33% cheaper than that of the ordinary form of cement walk, having 4 to 8 ins. of cinder foundation, 3 to 4 ins. of concrete, and a ½-in. finishing course. It can be sold at 12 cts. per sq. ft. in place and give 30% profit to the builder. In St. Louis, the last annual city contract for ordinary cement sidewalks was let at 13.99 cts. per sq. ft. Some of this new walk was laid at St. Louis in January, 1898, when 50 ft. of sidewalk, 6 ft. wide, was placed in front of the property of Prof. J. B. Johnson, M. Am. Soc. C. E. (now of the University of Wisconsin), who states that it gives entire satisfaction. The walk could not be extensively laid in St. Louis, however, without a change in the city specifications by an ordinance passed by the Council and House of Delegates.

The patents on the system of construction are owned by the Metalloid Sidewalk Co., St. Louis, Mo., which is now arranging with licensees for the manufacture of the walk in other cities.



SIDEWALK CONSTRUCTION WITH SLABS OF CONCRETE AND STEEL.
Metalloid Sidewalk Co., Makers.

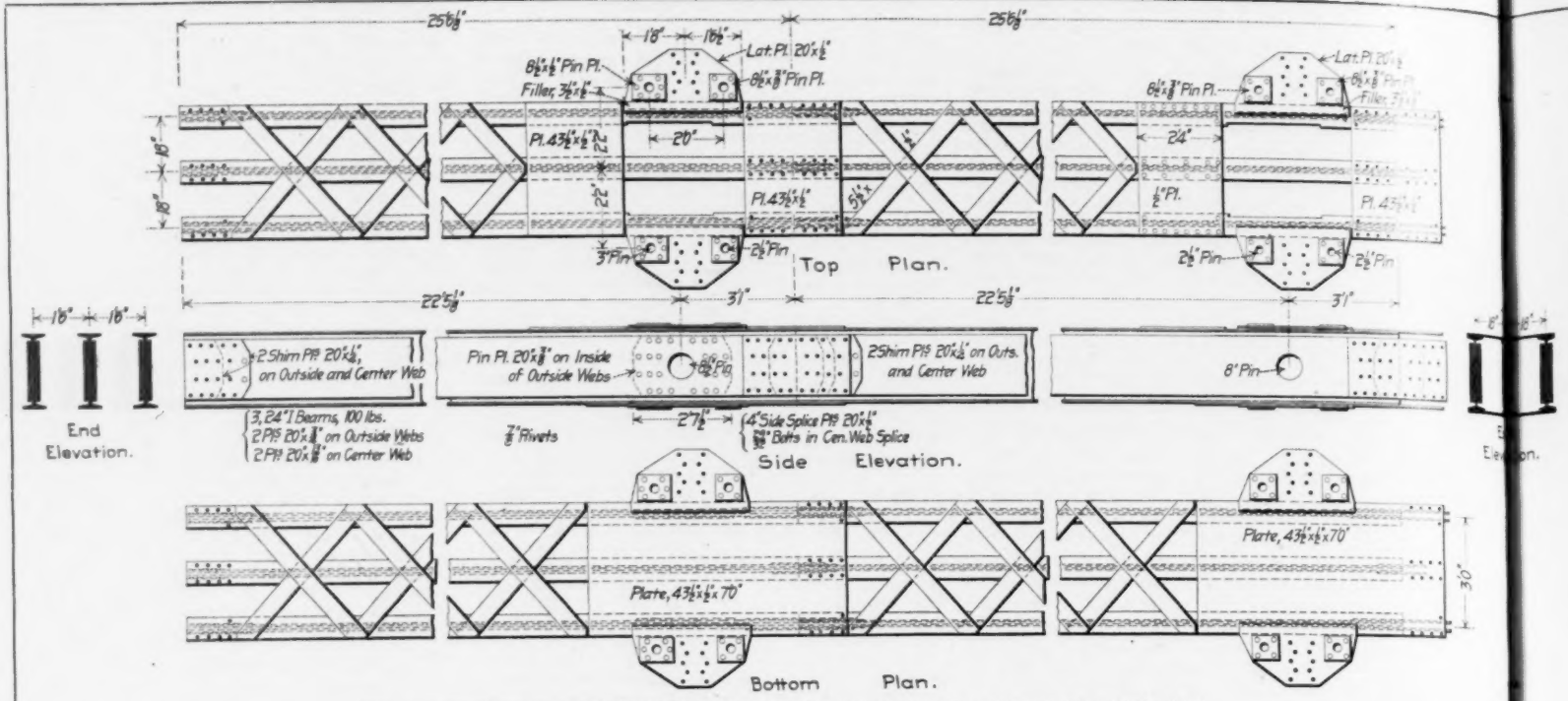

Top Plan.
End Elevation.
Side Elevation.
Bottom Plan.
2 Shim Pls 20"x1/8", on Outside and Center Web
Pin Pl. 20"x7/8" on Inside of Outside Webs
2 Shim Pls 20"x1/2" on Outs. and Center Web
3, 24" I Beams, 100 lbs.
2 Pls 20"x1/2" on Outside Webs
2 Pls 20"x7/8" on Center Web
7/8" Rivets
4" Side Splice Pls 20"x1/2"
7/8" Bolts in Cen. Web Splice
Plate, 43 1/2"x1/2"x70'
Plate, 43 1/2"x1 1/8"x70'

FIG. 6.—BOTTOM CHORD MEMBERS FOR THIRD AND FOURTH PANELS OF RIVER ARM.

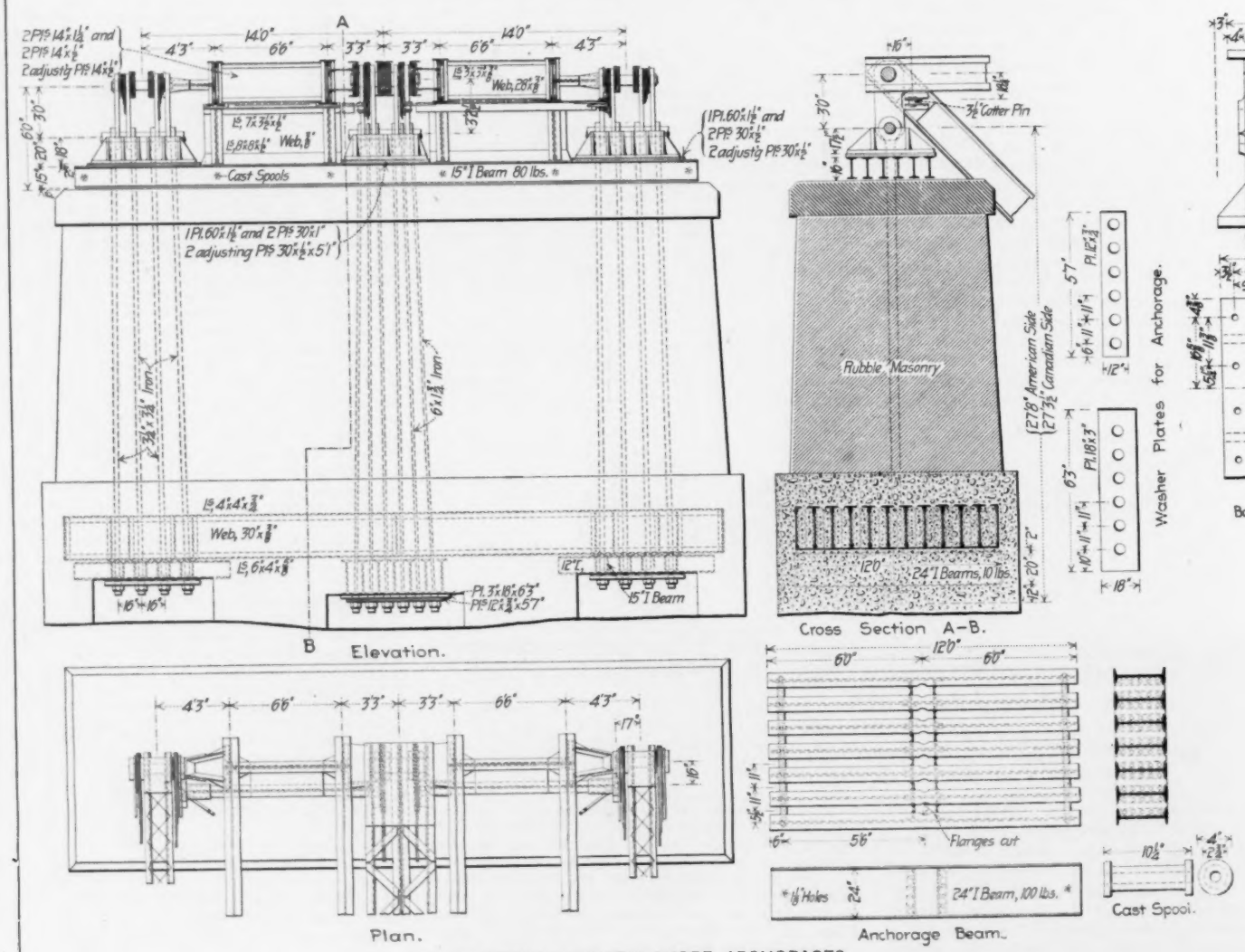


FIG. 1.—DETAILS OF NEW SHORE ARCHORAGES.

STRENGTHENING THE MICHIGAN CENTRAL R. ... CANTILE...

Alfred Noble, M. Am. Soc. C.E., Consulting Engineer; ... A. Torrey, Ch... Engineer
Detroit Bridge and Iron Works, De... Mich., ...

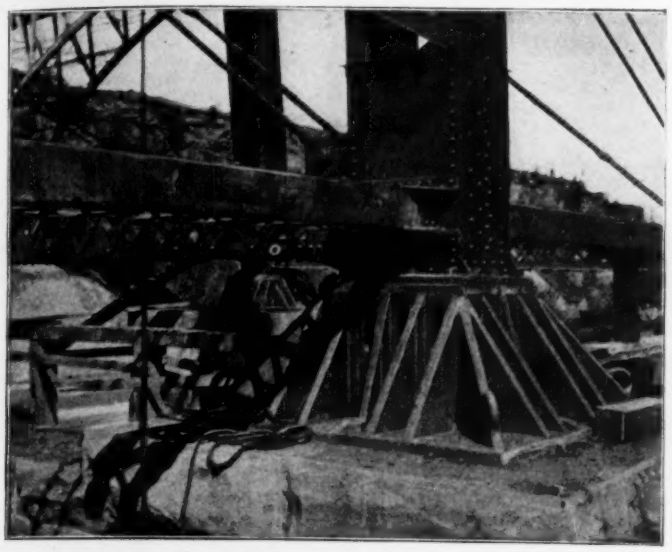


FIG. 4.—VIEW OF PEDESTAL CASTING FOR NEW TOWER LEGS.

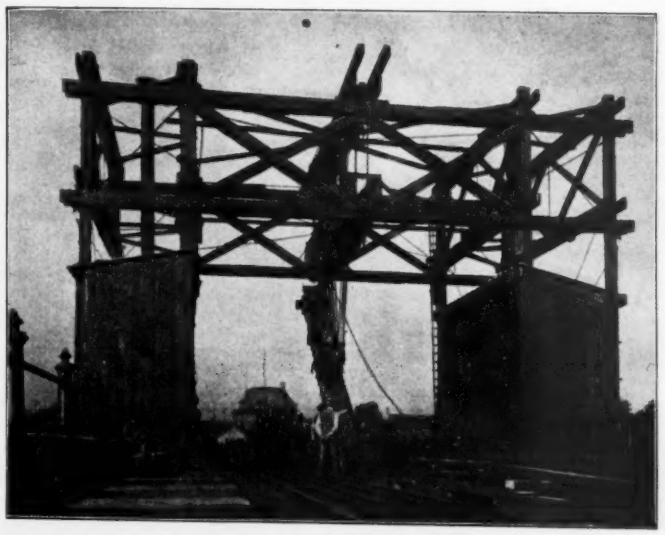


FIG. 10—VIEW OF TRAVELER FOR ERECTING CENTER TRUSS.

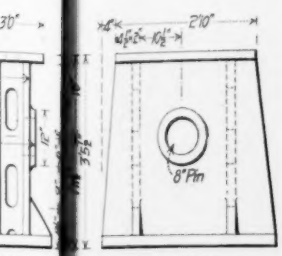


FIG. 5.—
DETAILS OF STEEL CASTINGS
FOR TOPS OF
NEW TOWER LEGS.

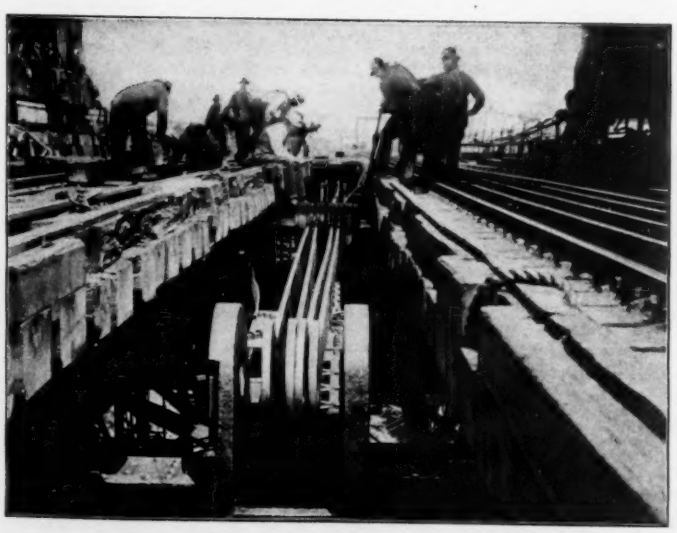


FIG. 9.—VIEW SHOWING PIN CASTINGS AND TOP CHORD
EYE-BARS BEING ERECTED.

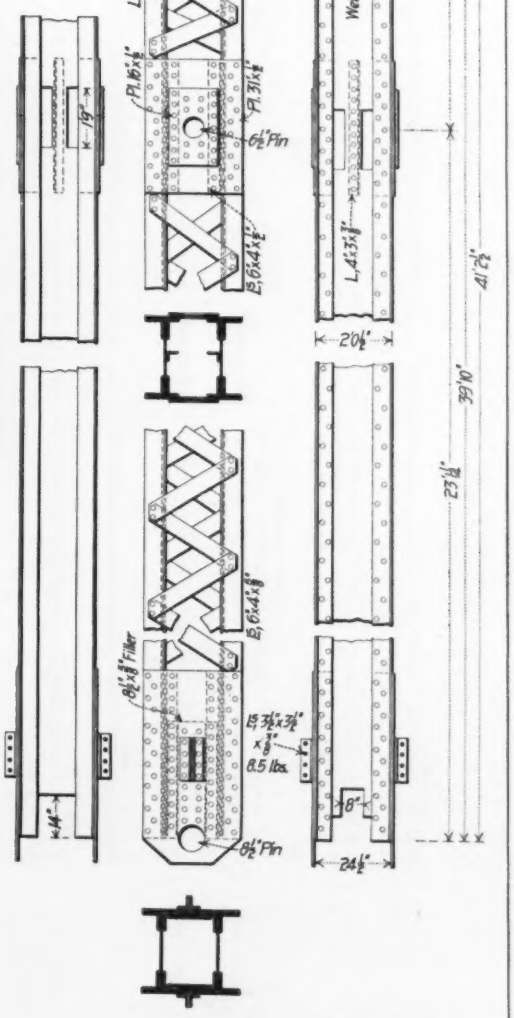


FIG. 7.—DETAILS OF VERTICAL POSTS
BETWEEN THIRD AND FOURTH PANELS
OF RIVER ARM.

FIG. 9.—VIEW SHOWING PIN CASTINGS AND TOP CHORD
EYE-BARS BEING ERECTED.

CANTILEVER BRIDGE, NIAGARA FALLS, N. Y.

Engineer;

Benjamin Douglas, M. Am. Soc. C.E., Bridge Engineer;

Mich., Contractors for Steelwork.